The Electrical Industry's Weekly Magazine April 3, 1961

Electrical World

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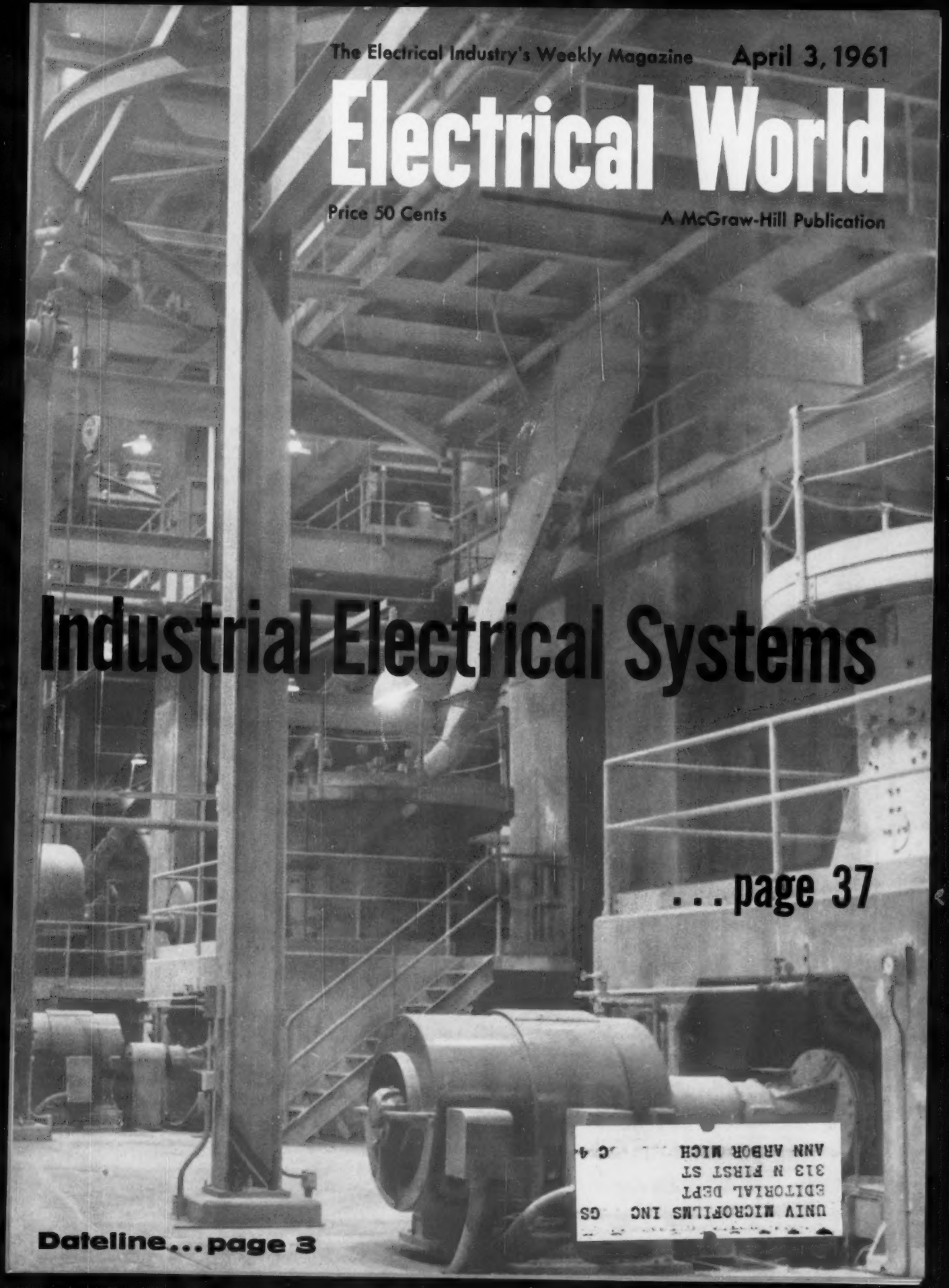

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Electrical World

APRIL 3, 1961

Vol. 155, No. 14

Dateline . . .

Democrats Begin Fight to Control FPC

Washington, D. C.—The Kennedy Administration is moving firmly to gain control of the chairmanship of the Federal Power Commission as quickly as possible.

The present Republican chairman, Jerome K. Kuykendall, may have a legal right to the post under current law until his term as a commissioner expires in June, 1962. He has shown no inclination to step down voluntarily.

Kennedy wants to install as chairman his own nominee to the Commission, Joseph C. Swidler, former general counsel of the Tennessee Valley Authority. Rep Oren Harris (D-Ark.), chairman of the House Interstate and Foreign Commerce Committee, has introduced legislation—reportedly at the request of the Administration—to resolve this impasse.

Harris' bill would extend the President's present power—to name a chairman for the duration of the appointee's term on the Commission—to allow removal of the chairman at any time, without any specific cause. The chairman of most other regulatory agencies hold their jobs under this condition.

The legislation proposed by Harris would also increase the membership of the Commission from five to seven, and increase the terms from five to seven years.

All three proposals were recommended by James M. Landis, Kennedy's advisor on regulatory agencies. They were expected to be part of Kennedy's package of recommendations on the agencies to be sent to Congress after Easter.

The move also underscores the importance of the chairmanship. Kennedy will have a numerical majority of appointees on the Commission by early summer, and he could make Swidler—or any other commissioner—chairman by June, 1962.

Of course, on any substantive matter, the majority rules, and the chairman has only one vote. In this sense, Kennedy appointees will gain control after Commissioner Arthur Kline's term expires in June,

(*Continued on page 5*)

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Dateline . . .

Washington, D. C. (*Continued from page* 3)
whether Swidler becomes chairman immediately or not.

Opponents of the Harris measure argue that it will impair the independence of the chairman. Some authorities on the FPC point to Kuykendall's reluctance to step aside as a perfect example of a chairman's independence of administration pressure —and they say this shouldn't be destroyed.

If the Harris bill is adopted, and Kuykendall is to be forced to step aside for Swidler, another crucial question is likely to arise: Can such a change in the law be applied retroactively?

Lawyers say this point has never been tested and that any action by the Commission under these circumstances would be under a legal cloud. They add that if Kuykendall didn't contest his own removal, investor-owned companies involved in the action would have to test it in court for their own protection.

Landis and Harris have both considered the possibility of enlarging the FPC to divide it into two divisions or two separate agencies, one to handle electric cases, and one for natural gas matters. While Landis still looks favorably on this plan, current sentiment in the House Commerce Committee is against it. It is doubtful if there is enough work for a separate division on electric matters, Committee sources say.

Swidler's nomination to the Commission will be taken up by the Senate Interstate and Foreign Commerce Committee on April 11. The nomination of Howard Morgan, former Oregon public utilities commissioner, will also be considered that day. Close checks of the Commerce Committee indicate that there will be opposition to Swidler, but that it will be confined largely to Republicans, and won't be strong enough to block his confirmation.

Letters

Site Report Out of Context

To the Editor:

The article entitled "AEC Annual Report Shows Progress" (EW, March 6, p 28) made a statement concerning the status of the Peach Bottom Project. Quoting from the last paragraph: "Set-back of the Philadelphia Electric Co's high temperature gas-cooled reactor at Peach Bottom, Pa., was because of a refusal by ACRS (Advisory Committee on Reactor Safety) to sanction the Peach Bottom site as 'satisfactory for a reactor of this general design and power level.'"

This is not a correct statement. The ACRS letter from Chairman Silverman . . . to (AEC) Chairman John McCone, dated Dec. 10, 1960, specifically stated in the last paragraph, "in view of the foregoing, the ACRS is not now prepared to go beyond its original conclusion reached in our letter to you under date of March 14, 1960, that the Peach Bottom site is suitable for a reactor of this general design and power level."

. . . The ACRS did request additional data on design and performance of certain components before it felt it could go beyond its original conclusion that the site was suitable. Additional laboratory and experimental data is being prepared to answer the specific requests for information made by the ACRS.

Robert E. Ginna, President
High Temperature Reactor Development
Associates, Inc, Rochester 4, N. Y.

To the Editor:

. . . What the AEC annual report (p 50) actually said was:

"The ACRS reported that, based on the status of reactor development, it could not go beyond its statement of March that the proposed site is satisfactory for a reactor of the general design and power level."

In other words, the ACRS, instead of refusing to sanction the Peach Bottom site, re-affirms its earlier sanction of the site.

Everett Holles, Director of Communications
General Atomic, San Diego, Calif.

▶We regret that the AEC quotation was made in the wrong context.

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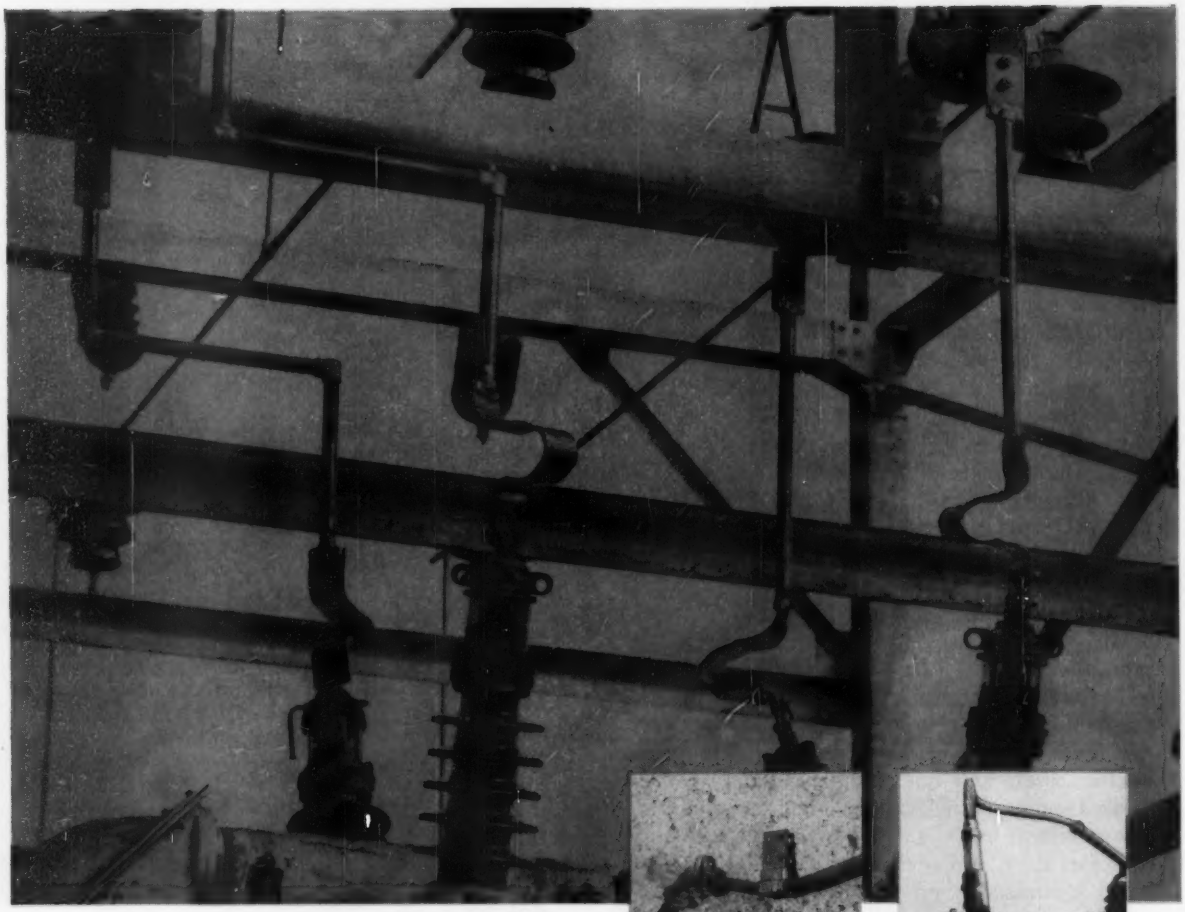
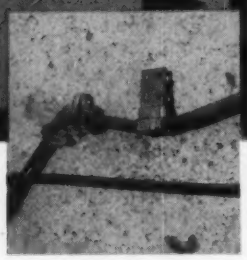
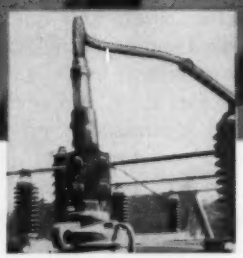




Lug tap off
strain bus cable



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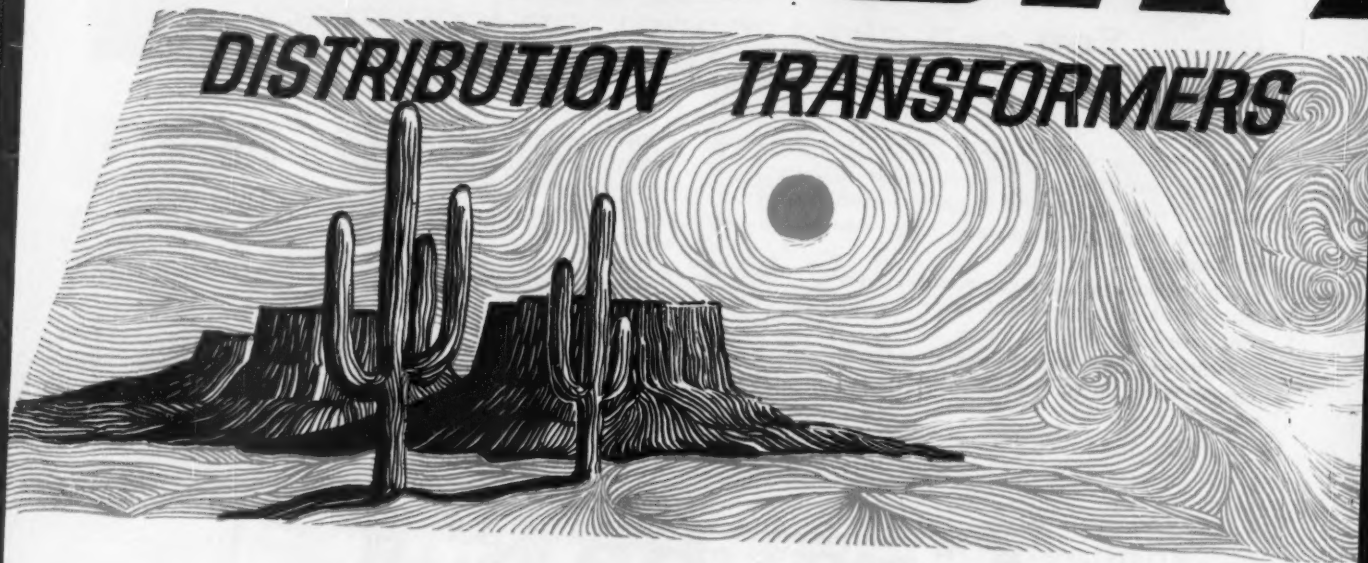

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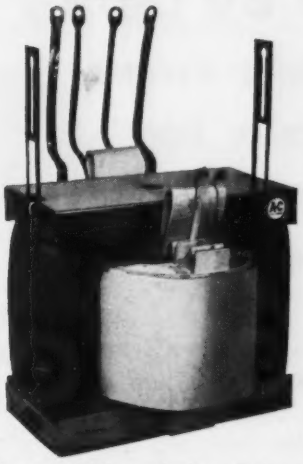

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new high-temperature oil . . . new high-temperature insulation . . . greater oil duct area in the coil.

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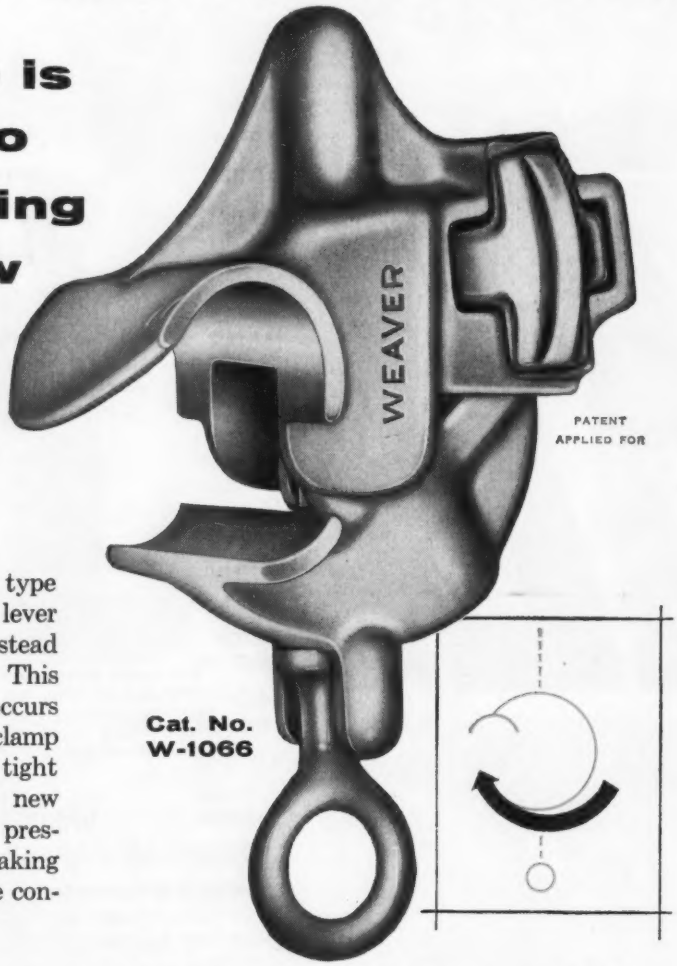

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WEAVER has developed a new type Aluminum Hot Line Clamp using the lever and fulcrum method for tightening instead of the ordinary straight line method. This principle eliminates the friction that occurs in the bolt-and-slider type of hot line clamp when the slider begins to pull up tight against the conductor. With the new WEAVER Hot Line Clamp, greater pressure is transmitted to the conductor making a higher conductivity, lower resistance connection... with less effort!

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LATE NEWS ▶

AEC will cut 1,000 Mw from its power requirements for facilities at Oak Ridge, Paducah, Ky., and Portsmouth, Ohio, over the next 3½ years. Most of the cut will come with lapse of contract with TVA for purchase of 660 Mw. Another 150 Mw comes from cancellation in two steps of an additional power agreement with OVEC signed in 1956. Another 200 Mw comes from cutback at AEC's own Oak Ridge generating station. Unaffected are a 25-year contract with OVEC for 1,800 Mw and TVA contracts for 1,200 Mw from Shawnee plant and 1,400 Mw from Kingston plant. The reduction has already had the effect of moving the operating date of TVA's planned 900-Mw unit at Edgemore, Tenn., back one year to 1965.

General Electric confirms that all of 15 employees sentenced in the recent antitrust cases have now resigned or left the company. The resignations in question have taken place variously from a time very early in the investigation until just last week. The resignations most recently made public by the individuals involved were brought about by the recognition that this was the only course serving the best interests of the people involved and the company, GE said.

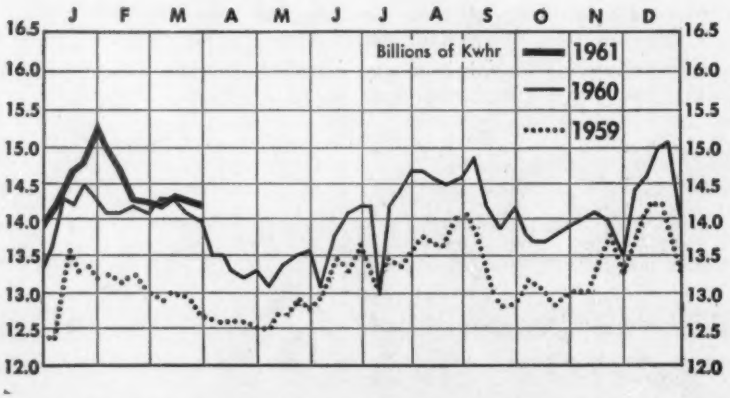
Technical problems delay start of commercial operation of Southern California Edison's computer-controlled generating units at Huntington Beach.

Sen Estes Kefauver sets hearings for Apr. 13-14 in Washington to investigate identical bids in the electrical industry. Names of witnesses to appear before the Antitrust & Monopoly subcommittee not disclosed.

GE vice president calls for new evaluation of electric industry's standards to help US industry compete in world markets. Clarence H. Linder tells Southeastern Electric Exchange Convention US standards should be trimmed closer to European pattern when higher performance is not really needed. He also says standards-making processes are too "cumbersome, complex, and expensive."

British Columbia Premier Bennett gives Ottawa two alternatives: Build and pay for the $458-million Columbia River project, or guarantee BC it will receive 4.25-mill power at Vancouver with permission to export surplus Columbia power to US. If Ottawa decides to go it alone, Bennett wants BC to keep $64 million received from US for flood control benefits, and the dam and lines to be turned over to BC within 50 years. If BC builds the dam, it wants guarantees that power price at Vancouver will not exceed 4.25 mills, and that surplus power will be bought by US at that price.

WEEKLY POWER OUTPUT—Up 1.6% (Week ending Mar. 25), Kwhr 14,291,000,000



Per Cent Change From Previous Year

	Mar. 11	Mar. 18	Mar. 25
Total U. S.	− 0.2	+ 0.5	+ 1.6
New Eng.	+ 4.8	+ 5.9	+ 5.0
Mid. Atlan.	+ 2.3	+ 4.2	+ 4.1
Cent. Indust.	− 5.8	− 4.0	− 2.7
West Cent.	+ 1.2	+ 3.1	+ 4.4
Southeast	− 5.8	− 5.0	− 2.2
South Cent.	+ 2.4	+ 3.6	+ 4.9
Rocky Mount.	+12.1	+ 9.6	+11.5
Pacific			
NW	+ 2.8	+ 3.6	+ 7.4
SW	+15.7	+10.0	+ 6.0

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Source: Edison Electric Institute

Supply Lines

GE FILES COUNTERMOTION AS OTHERS ASK TO SEE ANTITRUST SUBPOENAS

In Philadelphia, Federal Judge J. Cullen Ganey has set April 12 as the date for hearing oral arguments on California's motion concerning subpoenas issued during the recent antitrust investigations (EW, March 27, p 22). From information gathered last week, this is the position, essentially, of various interested parties: California, in its motion, said it wanted to see the subpoenas because this might help the state in assessing damages. US government attorneys said this was all right with them, but why not make the information completely public by filing it in the clerk's office?

On the other hand, General Electric Co has filed a countermotion asking that the subpoenas be impounded by the court and kept secret. Various other manufacturers have said to the judge that they would be against the California motion. In the meantime, some other states and municipalities have indicated that if California sees the subpoenas, they also should be allowed to. Finally, several investor-owned utilities have indicated that if public agencies see them, the investor-owned ones should also be in on it. Judge Ganey will have to decide whether or not to impound the subpoenas, and if not, just who, if anyone, should be allowed to have a look.

TRANSFORMER PRICE AGREEMENTS ORDERED ENDED IN BRITAIN

Britain's transformer manufacturers were told last week by a British court to end all price agreements because they were not shown to be in the public interest. The ruling followed 25 days of hearings on the price agreements, which, under British antitrust laws, can be legal if they are in the public interest.

Essentially, the agreements pooled market information and fixed minimum prices based on lowest costs but they were not used in the US export market because of this country's antitrust laws. Signatories to the agreements consisted of ten manufacturers who make all British power transformers and most of the smaller transformers. Some 50 to 60 other manufacturers who make only small transformers were not signers to the agreement.

In support of the agreements, the manufacturers used three main arguments: (1) Ending the agreements would mean a price war, eventually resulting in lower R&D expenditures and quality standards; (2) This unstable home market would mean a loss of business in export markets, because companies would not be willing to spend as much money to get export orders and would not have the pooled market information; (3) The manufacturers of larger transformers would not be able to get fair terms when selling to the government because of its overwhelming dominance as a purchaser of these units.

The court rejected all these arguments, saying that no manufacturer who wanted to stay in business would risk his good name by reducing quality. Moreover, ending of the export price agreement would mean greater competitiveness in a very competitive market and the end of identical bids, which apparently have caused British manufacturers to lose at least one large export order. Finally, the court said the manufacturers failed to prove that they wouldn't get fair terms in a free market when selling larger transformers to the government.

What the effects will be of the ending of price agreements on British manufacturers selling in the American market is not known. While spokesmen for these com-

panies had no immediate comment, the best guess is that nothing will happen to the prices they quote here. But there is the outside chance that if a price war started in Britain, it might spread to the exporting subsidiaries of the parent companies.

ANOTHER COMPANY GOES TO $117 FOR CAPACITORS

Another company has raised the price of capacitors to $117 for 50-kvar units following similar moves by other companies (EW, March 13, p 21). Line Material Industries said the new price went into effect March 27, and pointed out that on 100-kvar units the new price is $209.

Apparently, the $117 price has been used by some companies in recent sealed bid business, even though General Electric and others quoted the current market price of $97.33. When queried as to what it would now do, GE merely said it was studying the situation closely.

PRICE INCREASE ON SWITCH AND BUS INSULATORS MAY NOT STICK

An attempt to raise prices on special types of insulators may not be successful. General Electric said it was raising the prices of switch and bus insulators 3% on March 27. But late last week, I-T-E Circuit Breaker Co told *Electrical World* that after much deliberation, it had decided not to make a similar price increase. And two other companies which play a significant role in this market, Ohio Brass Co and Lapp Insulator Co, reported they still had made no decision regarding the General Electric price increase.

In explaining why I-T-E refused to go along with the GE move, an I-T-E spokesman said the increase would be "discriminatory and would put undue pressure" on small power switching equipment manufacturers who have to buy switch insulators from outside their company. The spokesman noted that PSE prices are currently very soft and that the independent manufacturers are having a hard enough time making ends meet without having to contend with higher insulator costs that larger, integrated manufacturers could absorb in other ways.

TVA SIGNS COAL CONTRACTS; DEFENDS SEALED BID PRACTICE

The Tennessee Valley Authority announced last week the signing of contracts worth $9,304,998 for 3,240,880 tons of coal. Last year TVA consumed 18,600,000 tons. While $2.87 was the average mine-mouth price per ton, the actual spread was from $2.42 to $4.84. When evaluated, including transportation costs and penalties for ash and sulfur content, the costs per million Btu varied from 16.52¢ to 19.81¢.

At the same time, TVA defended its practice of using sealed bids as a means of determining who its coal suppliers would be. Various regional factions have been pressuring TVA to buy from particular depressed areas even if those bids weren't lowest. A spokesman for TVA pointed out, however, that all its coal suppliers are in depressed areas, so that following such a policy of accepting higher bids would merely transfer unemployment from one area to another.

A. R. Waehner, Director of Transformer Product Sales, presents the story of L-M 32-step Regulators. Ask your L-M Field Engineer to show you why L-M Regulators are a better buy—how less weight permits cluster-mounting; how Round-Wound construction assures lower losses, higher short-circuit strength, how the design provides many other advantages in convenience, operation, reliability.

Ask Your L-M Field Engineer WHY L-M Regulators Are A Better BUY

Round-Wound® design provides better cooling, lighter weight for cluster-mounting, higher short-circuit strength. Voltage and band width adjustments are accurately made in minutes.

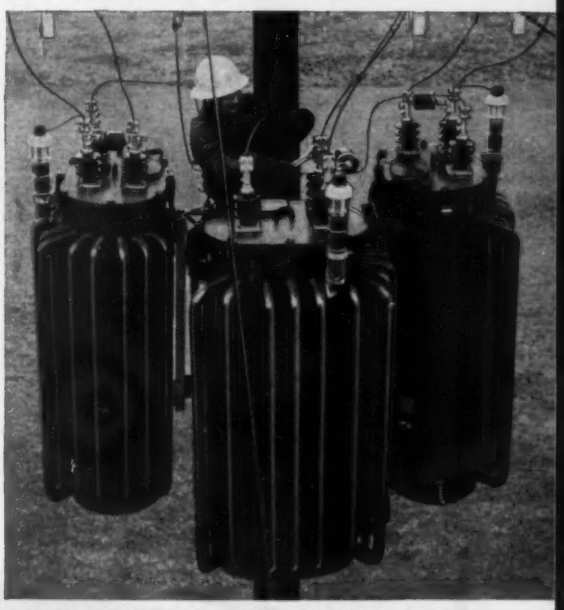
Only L-M's 32-step voltage regulators incorporate the Round-Wound principle of core-and-coil design. Round-Wound design provides faster heat transfer for better cooling.

More Compact—77% Lighter—Round-Wound core-and-coil assemblies are more compact. L-M regulators have shorter obround tanks requiring less oil. Up to 77% less weight permits cluster-mounting.

Higher Short-Circuit Strength—L-M's exclusive round coils withstand mechanical stresses of short-circuit currents better than other designs.

Rugged, Reliable—Only L-M regulators have the exclusive induction disc watt-hour type contact-making voltmeter. Control is more accurate, reliable and rugged. Calibration is easier with no interruption in service.

Get The Whole Story—Your L-M Field Engineer has the complete story on L-M's 32-step voltage regulators. Contact him today or write Line Material Industries, P.O. Box 510, Zanesville, Ohio.



5000 KVA OF LOAD REGULATED FROM A SINGLE POLE! Here three L-M 219 ampere, 7620 volt regulators are cluster-mounted to provide regulation on a 7620/13200 volt multi-grounded wye distribution feeder.

OUR 50th YEAR 1911 – 1961

LINE MATERIAL®
Industries
McGRAW-EDISON COMPANY

McGRAW EDISON

511

Regulators

DISTRIBUTION TRANSFORMERS • RECLOSERS, SECTIONALIZERS AND OIL SWITCHES • FUSE CUTOUTS AND FUSE LINKS • LIGHTNING ARRESTERS • POWER SWITCHING EQUIPMENT
PACKAGED SUBSTATIONS • CAPACITORS • REGULATORS • OUTDOOR LIGHTING • LINE CONSTRUCTION MATERIALS • PORCELAIN INSULATORS • FIBRE PIPE & CONDUIT

Before you buy MICROWAVE...see RCA

Find out for yourself why RCA Microwave systems are now providing more than a million channel miles . . . see how a system can be supplied to fill all your communications needs, can be engineered to meet your data handling and automation requirements of today and tomorrow.

TODAY, time-tested RCA Microwave is being extensively used in the petroleum industry, by electric utilities, turnpikes, municipalities and telephone companies for telemetering, facsimile, data processing, voice transmission and supervisory control.

TOMORROW, a high density microwave system will span the country to provide transcontinental communication and data circuits for vital projects of national significance.

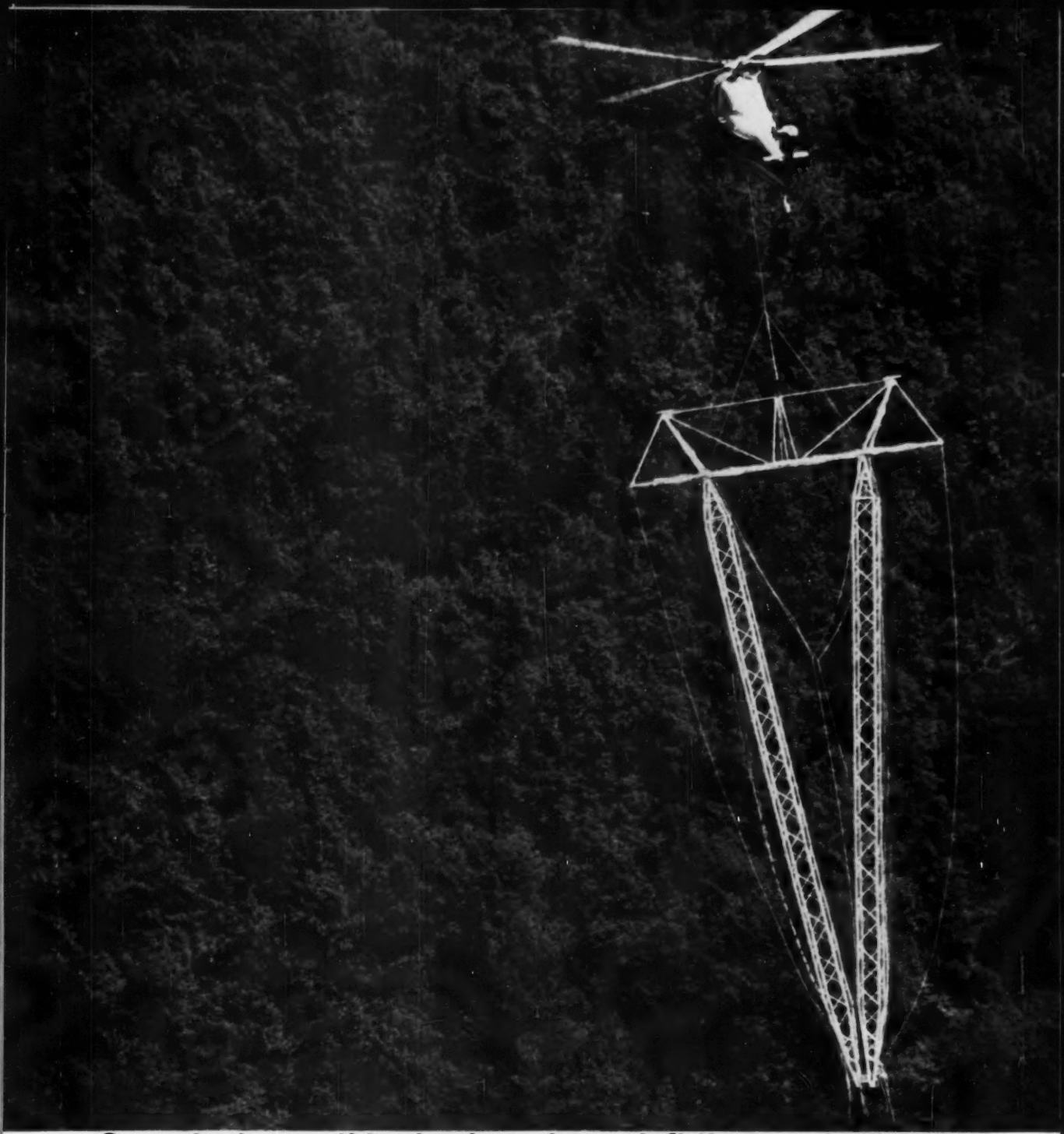
RCA is spearheading dramatic advances in the communications art and the first leg of this newly developed microwave system is now being installed.

Bank on proven experiences and creative communication engineering by enlisting the services of RCA to plan your total system requirements. If you desire, you can arrange for a complete communications and data handling network under one contract, one responsibility, one guarantee. With such a system, RCA furnishes and installs all equipment, provides all services from towers to tests. You receive a system designed to accomplish the jobs you specify. Give RCA the problem and you'll get a "task-engineered" system, ready for you to take over "on-the-air". For the complete communications story write to: RCA, Dept. T-45, Microwave Equipment, Building 15-1, Camden 2, N.J., or telephone WOodlawn 3-8000, Extension PC-4560.

RCA®

The Most Trusted Name in Electronics

RADIO CORPORATION OF AMERICA



One minute ago this aluminum tower left the marshalling yard

...in five minutes it will be standing on its foundation

In a history-making experiment in line construction, American Electric Power Company transported and erected a completely assembled V-tower by air.

The aluminum tower, designed for a 138-kv line, was airlifted at the assembly yard, flown 9/10 of a mile, set on its concrete footing, released, bolted and temporarily guyed—all in less than six minutes. With guys, the tower weighed 2,900 pounds—well within the capacity of the Sikorsky S-58 chosen for the job.

The demonstration, conducted by A.E.P.'s subsidiary, Appalachian Power Company, was but one phase of a six-week-long helicopter construction operation. The company used the Sikorsky S-58 to haul steel, poles and assembled H-frames...to erect tower panels ...to string cable. Carrying steel for 17 towers, for example, the helicopter completed what would normally be three weeks' work in just 4⅓ hours. Total time to construct 29 miles of line was cut to one-third of that required with conventional methods.

For more facts on helicopter services and the new role of rotorcraft in line construction, simply write Sikorsky.

SIKORSKY AIRCRAFT Division of UNITED AIRCRAFT CORPORATION
Stratford, Connecticut

IN NEW Wagner®

LIVE BETTER ELECTRICALLY

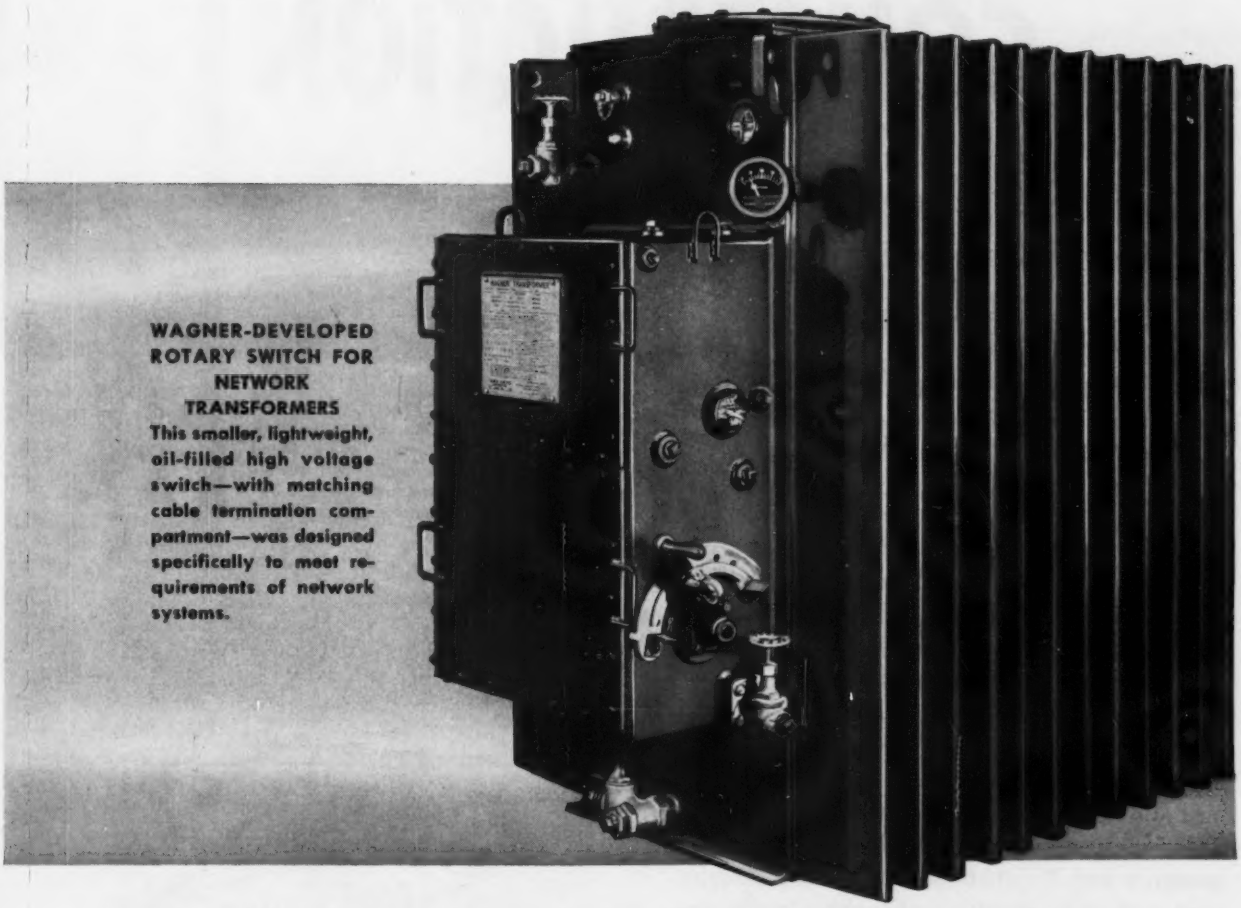
SIX 2000 KVA WAGNER NETWORK TRANSFORMERS installed on the system of Dallas Power and Light Company serve the Southland Center. The 42-story Southland Life Tower and the 600-room Sheraton-Dallas Hotel consume an enormous amount of power . . . power used, for example, by 15,800 lighting fixtures, 28 elevators, 8 escalators, an all-electric company cafeteria, and a 6,450 ton electrically-driven air conditioning system.

SERVING 2 GREAT GROWTH INDUSTRIES
. . . ELECTRICAL
. . . AUTOMOTIVE

NETWORK SYSTEMS... or OLD

Network Transformers

will fit in close quarters... are small in size... have compact rotary switch... modern, corrugated cooling surfaces



WAGNER-DEVELOPED ROTARY SWITCH FOR NETWORK TRANSFORMERS
This smaller, lightweight, oil-filled high voltage switch—with matching cable termination compartment—was designed specifically to meet requirements of network systems.

Wagner® Network Transformers are designed to give you smaller, lighter units, with smoother contours for easier maintenance. In new networks you can cut system costs by constructing smaller vaults to hold these space-saving transformers. In older systems you can put larger ratings in your present vaults. Maintenance costs are less, too. The corrugated radiators can be quickly cleaned from above, and an anti-corrosive tank finish protects exterior surfaces for years. A special undercoating on the base protects the transformer even under adverse conditions of underground installation.

CORRUGATED TANK-COOLING SURFACES eliminate dirt-catching corners. Radiating surfaces are easy to clean, and there are no hard-to-get-at spots to hinder painting when it's needed. Reliability is improved because there are fewer places for leaks to develop.

LOWER NOISE LEVEL has resulted from improvements in core design and materials, and newly developed methods of annealing the core steel. Lower noise levels are a feature of all Wagner transformers.

Over 65 years of constant research and development have made Wagner a leader in transformer design... made the Wagner name one of the foremost in power planning. For expert advice in solving your network transformer problems, consult your nearby Wagner Sales Engineer. There are Wagner branches in 32 principal cities.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

Wagner Electric Corporation

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WT61-7

LAPP CONTROLLED-POSITION CONSTRUCTION

A new type of insulator from Lapp offers cost reduction, economy of space and convenience of construction to solve many problems of transmission line design

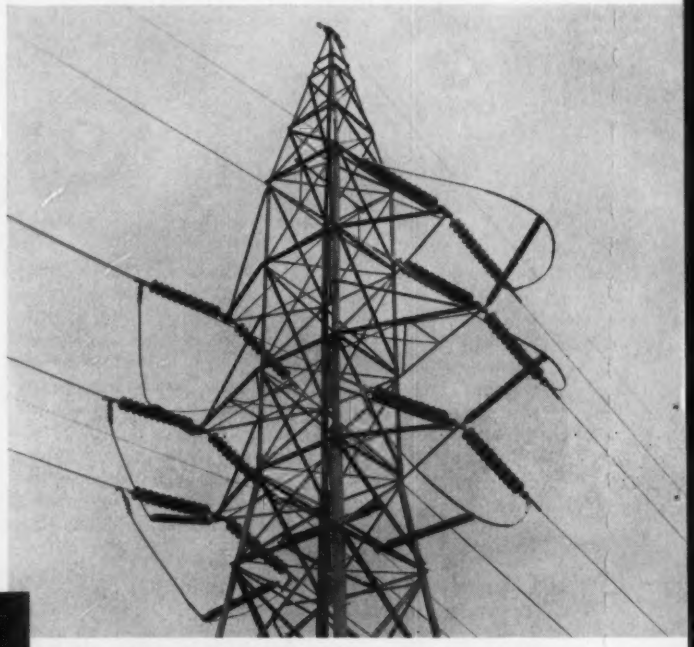
Lapp strut insulator, 117" long, matches electrical and mechanical ratings of an 18-unit string of 5¾" x 10" standard suspension insulators.

Lapp Controlled-Position Construction is a new technique in transmission line design which utilizes porcelain rods or struts—with fog-type leakage corrugations—to hold in fixed position and/or restrain high voltage conductors.

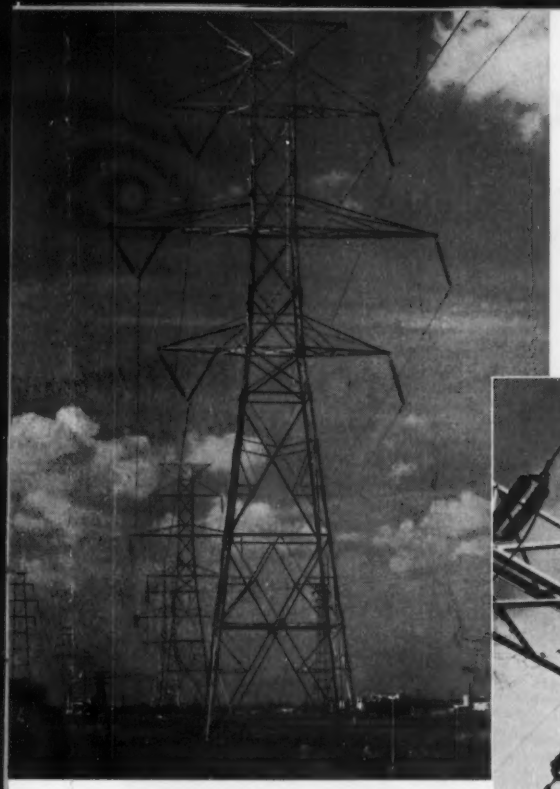
Use of Lapp Controlled-Position Construction on tangent structures invariably results in more compact design with consequent lower structure cost and narrower right-of-way requirements. Its use in jumper restraint provides neat efficient appearance and eliminates radio and TV interference such as is generated by lightly-loaded suspension strings.

WRITE FOR BULLETIN. Lapp Brochure No. 478 describes the development and application of Lapp Controlled-Position Construction . . . suggests design procedures . . . lists specifications and characteristics of Lapp strut insulators. Write for your copy.
Lapp Insulator Co., Inc., Le Roy, N. Y.

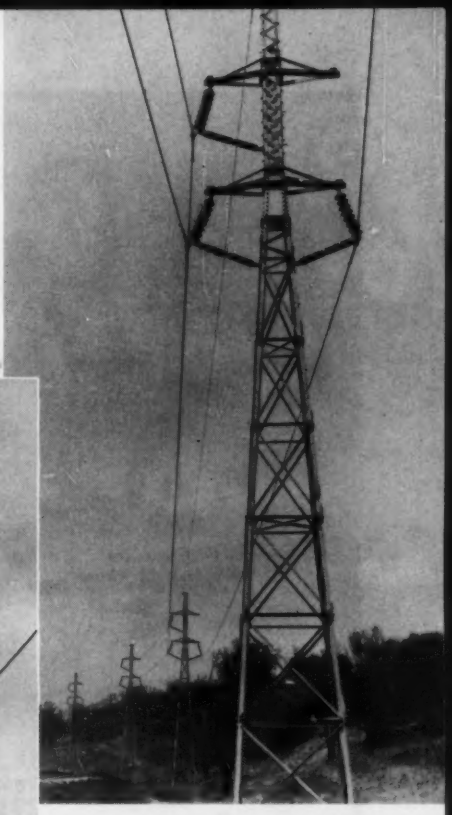
Lapp

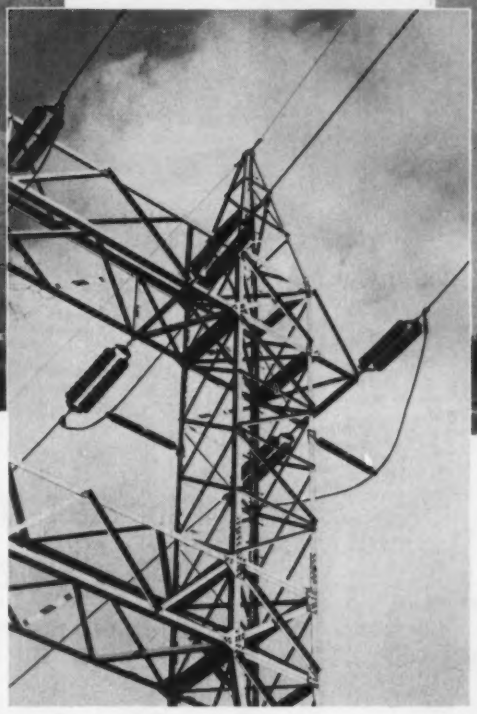


138 kv LINE AT HALF-PRICE! Conversion of 69 kv line to 138 kv accomplished with Lapp Controlled-Position Construction. Existing tower required only some reinforcement. Short crossarms are adequate, however, with use of Lapp strut insulators, to control dead-end jumpers, prevent their swinging, and maintain clearance from tower and between phases. Total construction cost: less than half that estimated for a new 138 kv line.



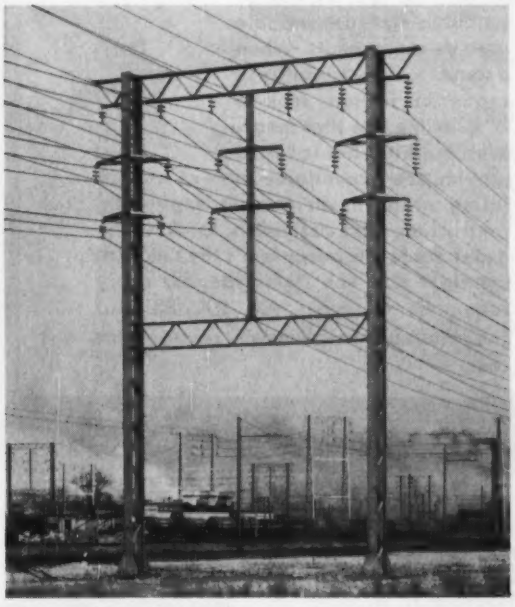
LONG JUMPERS STAY PUT! Lapp Controlled-Position Construction restrains long jumpers. This 115 kv dead-end structure keeps the line within its limited right-of-way—Lapp struts hold the 26 ft. jumpers safely away from the tower. No radio or TV interference either, as occurs with suspension strings used for jumpers.



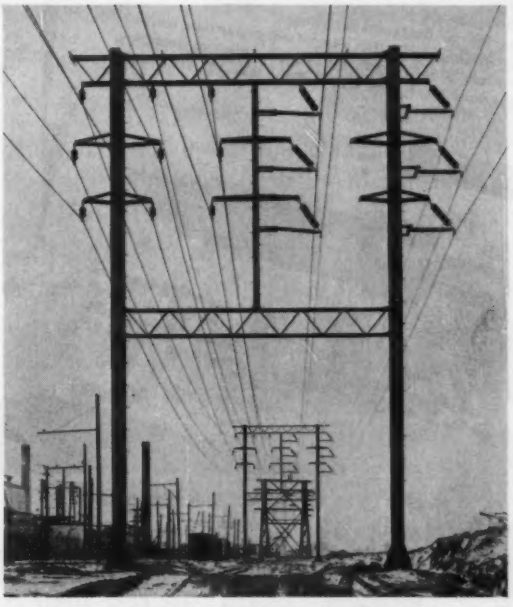


CUTS SHORT ON THE TURNS! Lapp Controlled-Position Construction is well suited for angle construction at high voltage. As on this 220 kv line, Lapp struts supported from crossarms and attached to lower end of suspension string are used to maintain clearance, holding conductor out and away from the tower. No need for longer crossarms, arm-end brackets or other construction that add cost or right-of-way requirements.

RADIO-TV INTERFERENCE ELIMINATED! As originally built in 1924, this 115 kv line used wood lower crossarms and tie-down insulators to stabilize conductor at angle structures. Recently reconductored, using Lapp Positioned-Construction. Lapp strut insulators position conductor and assure tower clearance. Radio and TV interference generated by tie-down insulators is now wholly corrected.



BEFORE 35-year old steel tower line carrying three 69 kv and three 12 kv circuits. Increased load required replacement of the three 69 kv circuits with two 115 kv circuits. The three 12 kv circuits were to be retained, and old portal-type steel structures were to be used; additional right-of-way not available.



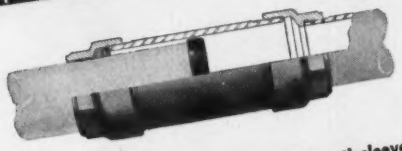
AFTER Same line after conversion. Two reinsulated 115 kv circuits are suspended from original crossarms. Lapp strut insulators attached to extension brackets on the towers push conductor-insulator assembly up and out, provide adequate clearance between circuits, tower and ground. 12 kv circuits remain.

in the long run... it's O.Z.

Type AX

Provides 4" expansion, contraction movement. Malleable iron head, body Hot Dip Galvanized. Weatherproof head sealed by factory-installed high grade graphite packing. Insulating conduit end bushing eliminates cable abrasion. 10 sizes for conduit ½" to 4" diameters.

Type EX



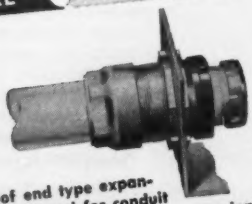
Permits 8" conduit movement. Optional length sleeves, additional cost. Weatherproof head sealed by factory-installed high grade graphite packing. Insulating bushings prevent cable abrasion. Hot Dip Galvanized finish. 12 sizes for ½" to 6" conduit diameters.

Type DX

Patented

Compensates for deflection, expansion, contraction. ¾" movement all directions from normal; 30° angular movement. Also used as vibration damper between conduit sections. 10 sizes. Watertight (NEMA 4) and submersible under 25 ft. head of water.

Type EXE



Weatherproof end type expansion fitting. Designed for conduit terminating in junction box, where expansion, contraction take place. Supplied complete: locknuts, bushings. Standard finish, Hot Dip Galvanized. 12 sizes.

Type TX

Similar to the Type AX, this unit is supplied complete with extension nipples, ready to receive thin wall couplings. Standard finish is cadmium plated. Available in 6 sizes for conduit ranging from ½" to 2".

for the longer line of EXPANSION FITTINGS

In the long run, no line of conduit is more dependable than its components. When it comes to dependability in expansion fittings, look to O. Z. as the line that measures up! Five basic types provide the dependable answer to your fitting problems in conduit expansion, contraction, and deflection. O. Z. is the dependable line because it's the line with the *right size*, the *right type*, for every requirement! Types AX, DX, EX and EXE available in aluminum at no extra cost.

O.Z. ELECTRICAL MANUFACTURING CO., INC.

262 BOND STREET • BROOKLYN 17, N. Y.

- CAST IRON BOXES
- CABLE TERMINATORS
- POWER CONNECTORS
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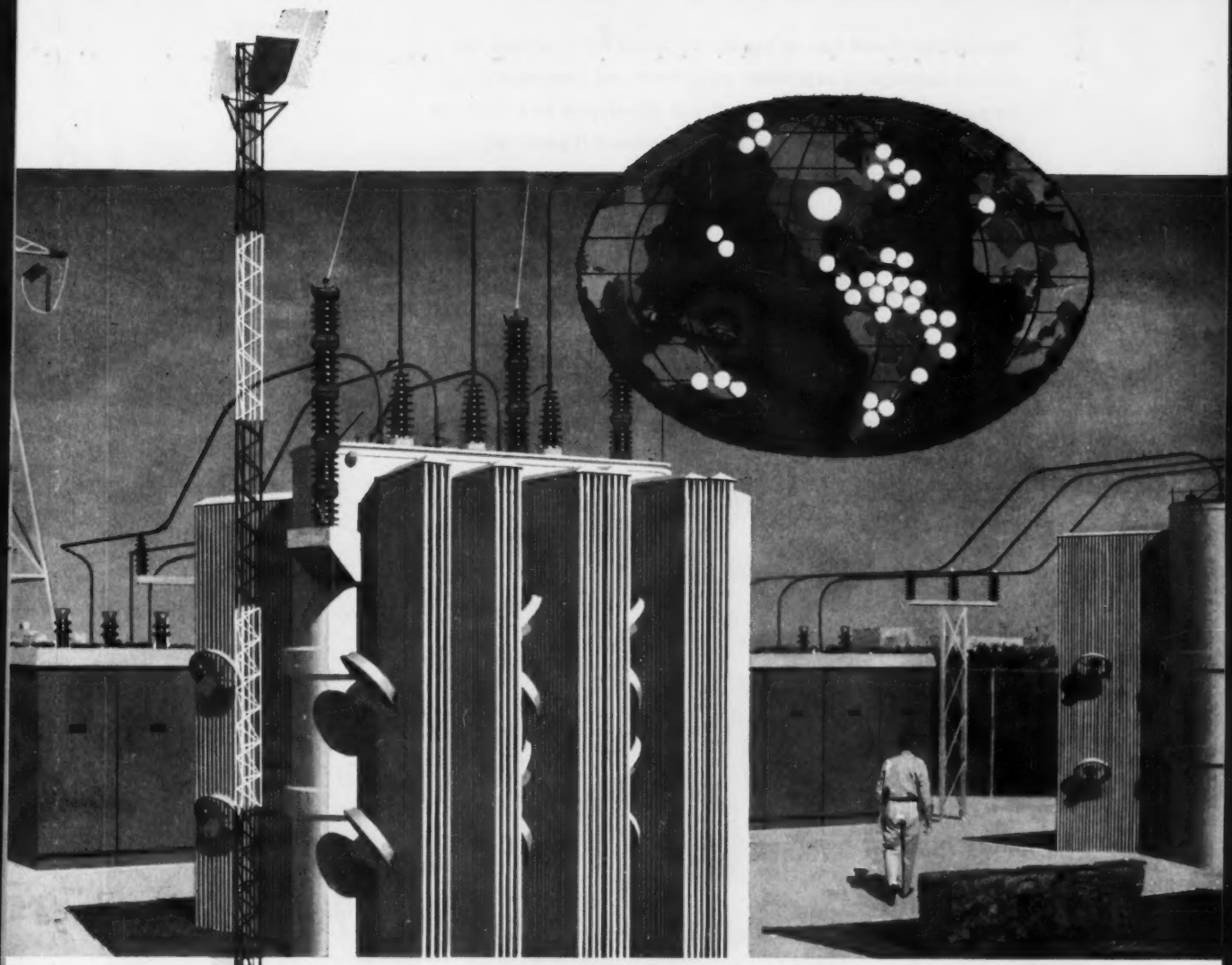
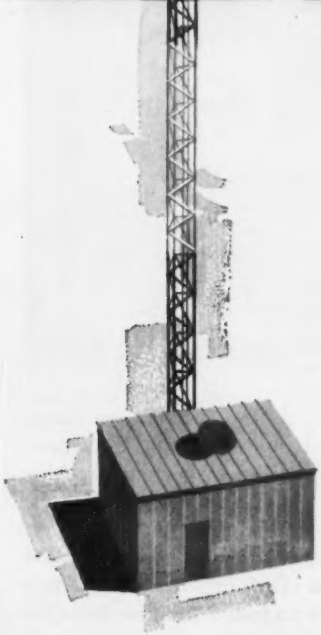




FOR PROVEN RELIABILITY UNDER ALL CONDITIONS . . . CHOOSE COLLINS

In electric utility communications, monitoring and control, and in many other types of installations throughout the world . . . in every extreme of climate and over every kind of terrain . . . Collins microwave-carrier systems have proved and are proving their reliability where it counts — on the job. For information on how Collins may help you solve your own particular communications problem, contact Collins Radio Company, Texas Division Sales, 1930 Hi-Line Dr., Dallas 7, Texas.

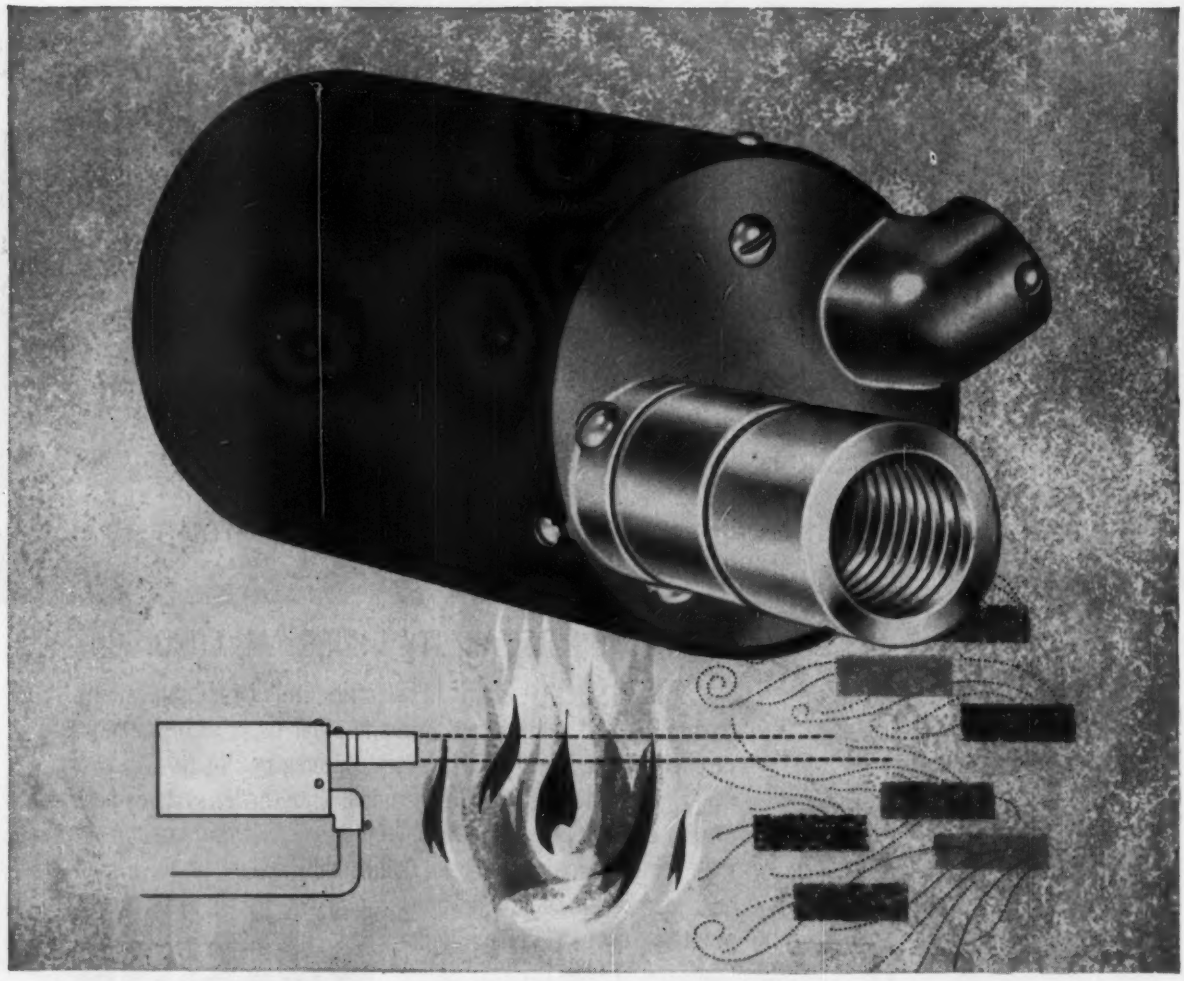
COLLINS MICROWAVE AND CARRIER

COLLINS

COLLINS RADIO COMPANY • DALLAS, TEXAS • CEDAR RAPIDS, IOWA • BURBANK, CALIFORNIA

Undetected flame failure can cause costly interruptions, do serious damage to expensive equipment and endanger lives. To prevent such loss, Honeywell has developed an ultraviolet flame detector that won't be fooled, because it positively differentiates between flame and hot brick.

This flame detector



Now, for the first time, you can be absolutely sure that fuel delivery will be stopped in the absence of flame. Honeywell's new C7012A Ultra-Vision* Flame Detector employs an amplified ultraviolet signal to positively distinguish between an actual flame (ultraviolet rays) and a hot refractory (infrared rays). This revolutionary new ultraviolet sensor represents a major breakthrough in scientific flame detection.

Because this compact new control device is not sensitive to a hot refractory, flame supervision of both single and multiple burners is simplified. The Ultra-Vision Flame Detector can be aimed at each individual flame in the most convenient way. It is the only device on the market that offers you this advantage.

Best of all, this new flame detector saves you money. Wiring is less expensive in this system than in a lead sulphide cell. It is easier to install because hot refractory can be ignored. And there is no further need for flame rod replacement.

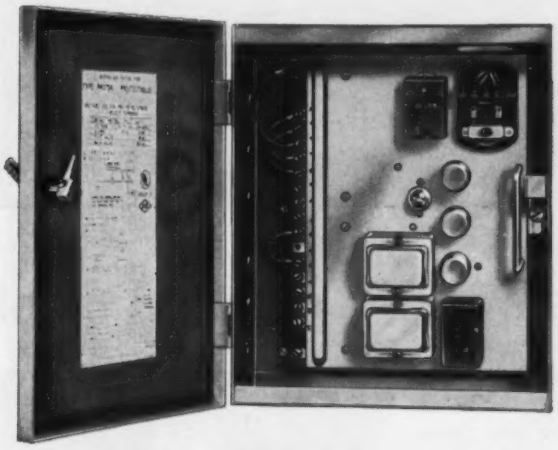
senses only the flame!

New Honeywell Protectoglo relay assures "maximum safety"

Available for use with the Ultra-Vision Flame Detector or with standard flame rods is Honeywell's famous R4075 Protectoglo* relay.

This new relay features "maximum-safety" self-checking which is particularly desirable for continuously burning industrial burners. A self-checking circuit checks the circuit and the components of the Protectoglo *once every second.*

The mounting cabinet of the Protectoglo has all-voltage terminals and a quick-disconnect control base that enables you to remove the relay without disconnecting any of the wiring. Plug-in components can easily be removed and replaced if necessary.



In addition, flame-rod assemblies are available to meet every industrial application. Alarm contacts can be powered from separate line or low-voltage circuit. And a special zinc dichromate finish resists the corrosive effects of most industrial atmospheres.

*Trademark

Honeywell protects Los Angeles' new $65,000,000 power plant

Los Angeles' Department of Power and Water installed the Honeywell Ultra-Vision Flame Detector and Protectoglo System to insure maximum flame safeguard protection for its new Scattergood Steam Plant. This huge power facility covers a 57-acre ocean front site south of the Playa del Rey district of Los Angeles.

The plant now uses two 91-foot-long turbine generators to produce 320,000 kilowatts of power. When the entire complement of six generators is put into operation, the anticipated output will be 1,200,000 kilowatts.

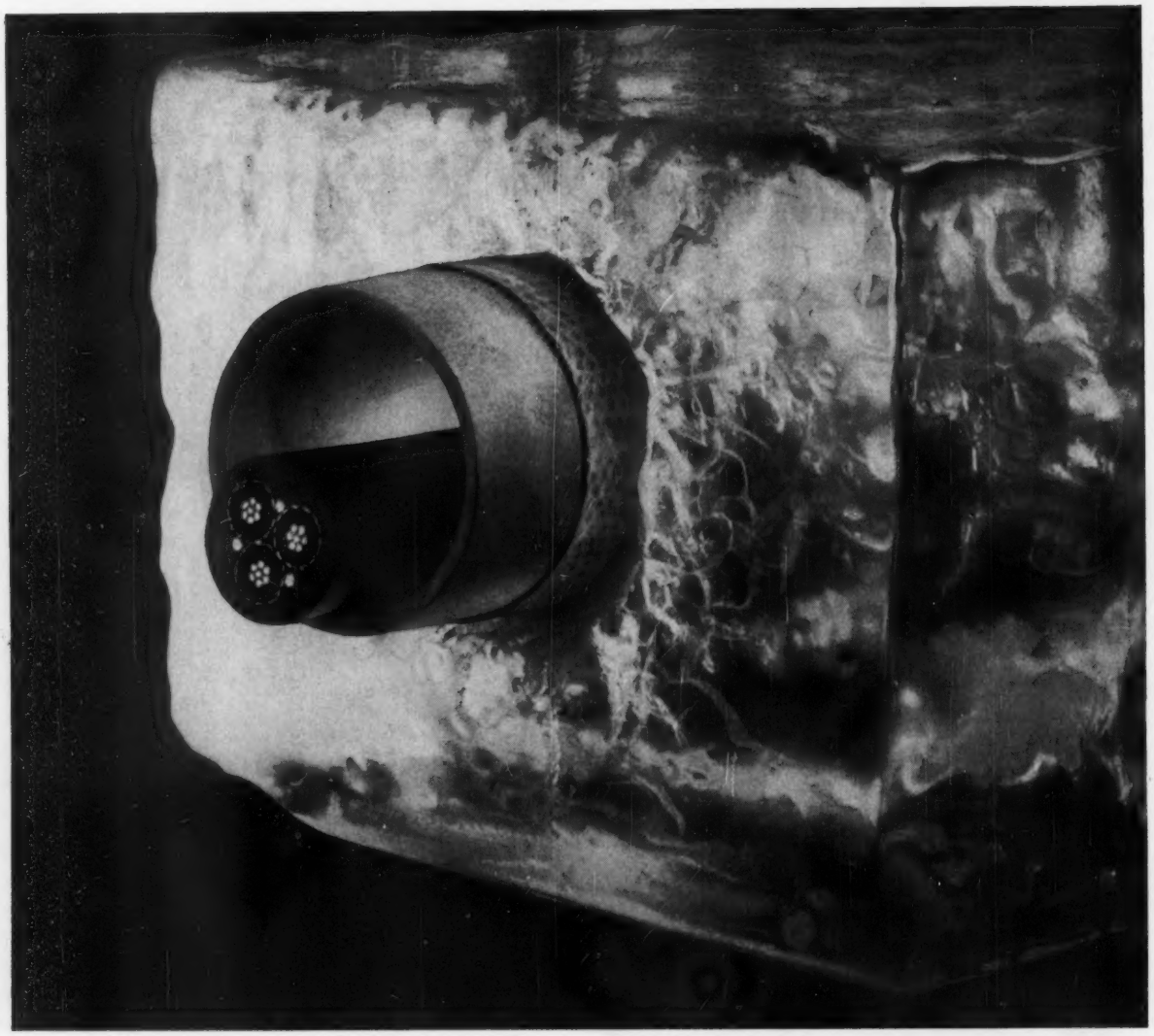
Gas, oil or a combination of both fire the Scattergood boilers. Gas consumption under full load is approximately 1,520,000 cubic feet per hour, and oil is used at 250 barrels an hour. Boilers are 133 feet high and furnace volume is 65,000 cubic feet.

For full information about Honeywell Flame Safeguard Control Systems, call your nearby Honeywell office. Or write Honeywell, Dept. ET-4-23, Minneapolis 8, Minnesota. In Canada, write Honeywell Controls, Limited, Toronto 17, Ontario.

Honeywell

H HONEYWELL First in Control

SINCE 1885

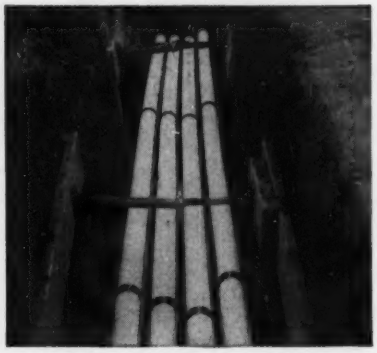


Cooler cables at lowest costs with Transite Ducts!

Do you know that electrical system losses amount to more than four hundred million dollars annually? Research shows that these losses can be drastically reduced by improving the dissipation of heat from conductors under load. The most efficient and economical way to accomplish this is with inorganic Transite® Ducts.

Tests prove that asbestos-cement Transite Ducts can actually have as much as 10.6% greater heat-carrying ability than organic ducts. This means that when a conductor is supplying a given load, its temperature will be substantially lower in Transite. These cooler cables result in lower electrical resistance with correspondingly lower I^2R losses. At a $20/KW cost, this can save you as much as $8.20 per thousand feet a year. Lower operating temperatures mean longer cable life and more reliable service, too!

Because of their 10′ lengths and speedy coupling method, Transite Ducts can be installed at the lowest cost. Get the full story by writing Johns-Manville, Box 14,TW-4, New York 16, N. Y. In Canada: Port Credit, Ontario.



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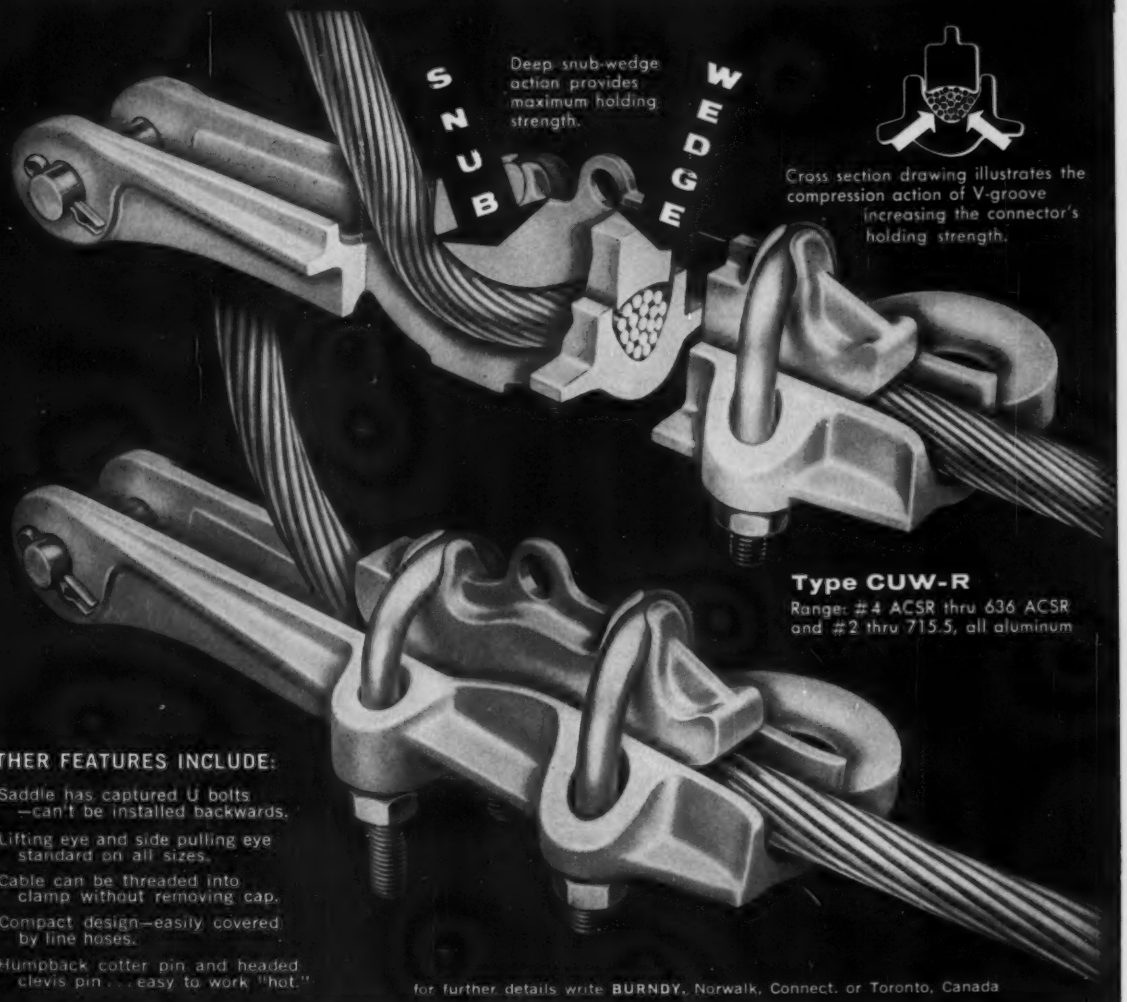
JM

get the inside story on this aluminum

DOUBLE ACTION LOW COST DEAD END CLAMP


SNUB
WEDGE
Deep snub-wedge action provides maximum holding strength.
Cross section drawing illustrates the compression action of V-groove increasing the connector's holding strength.

Type CUW-R
Range: #4 ACSR thru 636 ACSR and #2 thru 715.5, all aluminum

OTHER FEATURES INCLUDE:

- Saddle has captured U bolts —can't be installed backwards.
- Lifting eye and side pulling eye standard on all sizes.
- Cable can be threaded into clamp without removing cap.
- Compact design—easily covered by line hoses.
- Humpback cotter pin and headed clevis pin . . . easy to work "hot."

for further details write **BURNDY**, Norwalk, Connect. or Toronto, Canada

BURNDY

REVERE Dual Gauge TUBE

of 80/20 Cupro-Nickel

used in A. O. Smith's feed water heaters in newest installation at Wisconsin's largest power plant

(Above) *Tubes being bent at JOHANN TUBE & PIPE BENDERS, Milwaukee, Wisconsin.*

(Below) *"A"—Oak Creek Plant of WISCONSIN ELECTRIC POWER COMPANY.*

"B"—Tube bundle before assembly,

"C"—Interior of channel showing tube sheet and pass plates.

The six A. O. Smith Feed Water Heaters recently installed in the #4 unit of the Oak Creek Plant of the Wisconsin Electric Power Company, represent the fourth such set serving the four units. Heaters are 24" in diameter with overall lengths up to about 23'. Operating pressures are 2400-2500 psi. Enclosure and channel tested out at 4800 psi.

To take the kind of bending necessary in this "U" type heater, and still maintain the required wall thickness throughout its entire length, the tube must be of the best quality and of the proper, uniform grain structure.

Revere Mills have the facilities to produce just such consistently uniform tube while Revere's Technical Advisory Service has the knowledge to recommend the metal or alloy best suited to the job it must perform.

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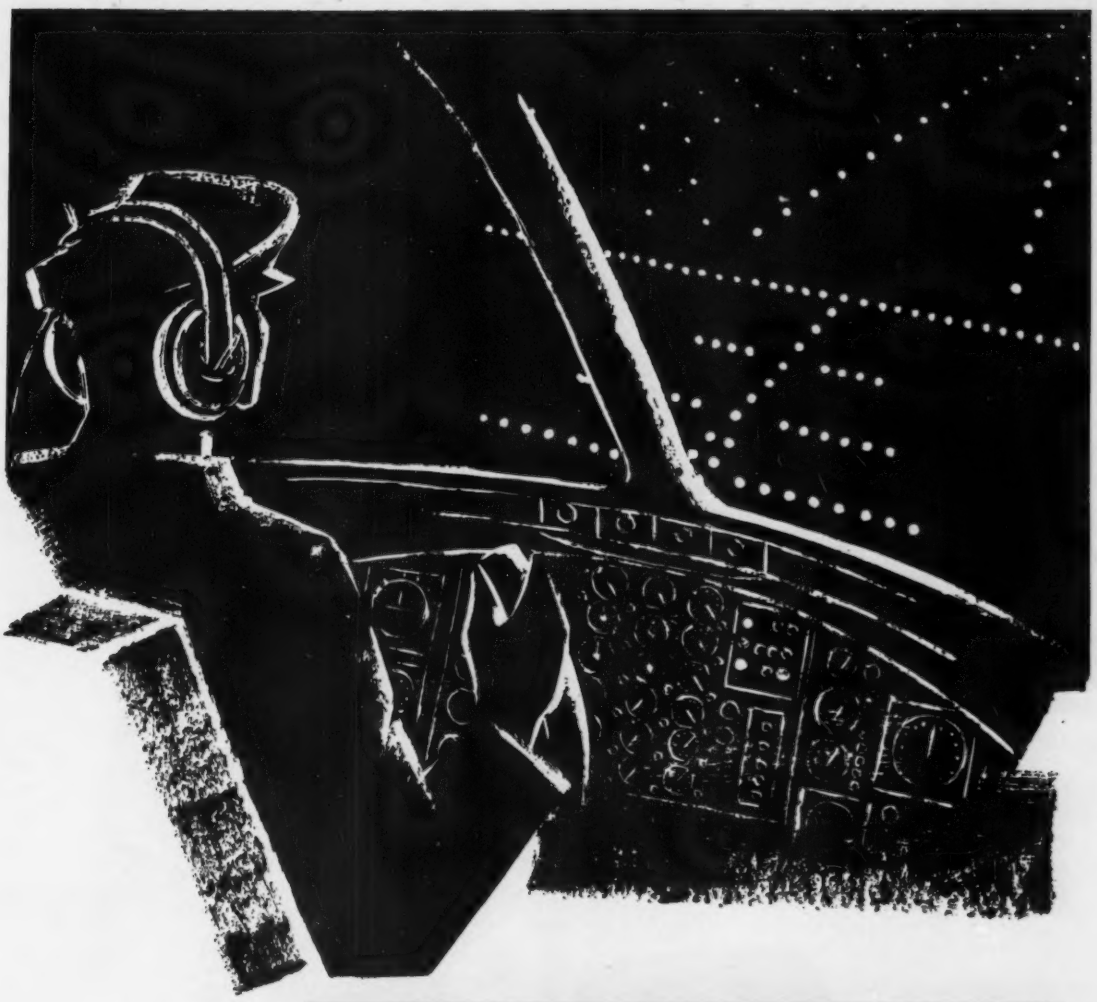

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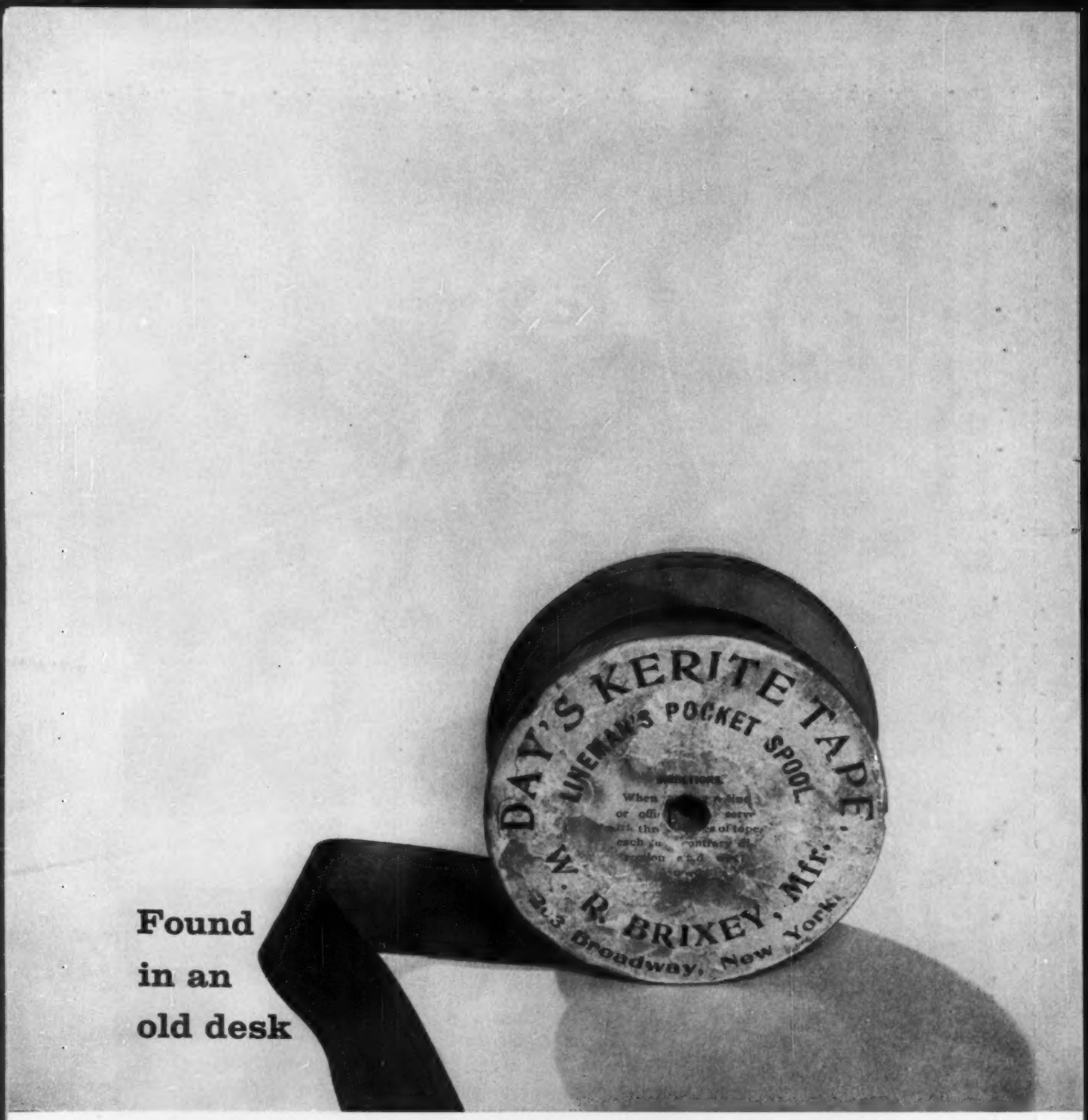

Found in an old desk

When this spool of tape was new, the twentieth century had not yet been born. Salty old Captain Brixey owned the Kerite business and was making cable history.

His Kerite wire had been used for a 300-mile railway block-signal system . . . the longest aerial cable of its time. A Kerite 1,000,000 circular mil power cable laid in the Gowanus canal was already ten years old in 1908 and "just as good today as it ever was and giving the best possible service."

One of the Captain's most colorful projects was the Kerite cable laid along the Panama Canal, the first telegraph connection between North and South America. The joints were made with Kerite splicing compound (Kerite insulation in tape form). These joints were not only dielectrically sound but had to match the cable insulation in terms of insulation resistance and capacity in every way. Thirty miles of this cable were submerged, but in jungle and water, cable and tape stayed in service for over forty years.

A lot of time has gone by since this spool was young.

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Editorial Comment

APRIL 3, 1961

Kennedy Backs Up His Power Policy

If President Kennedy's previous utterances on electric power policy left any doubts as to where he stood, his budget review message (p 32) should dispel the doubts. On the surface, the additional $100 million requested for power-related projects might seem rather modest to some observers, but as the story in this issue suggests, these are "foot in the door" requests.

Additional loan authority for the Rural Electrification Administration speaks for itself. The new Administration has said that it will look with favor on loan applications for generating and transmission facilities.

The modest additional $2.3 million for Bonneville Power Administration is just the first installment of an ultimate commitment of $32.4 million for transmission line construction.

The $30.1 million addition to Atomic Energy Commission's construction budget along with a reallocation of a similar amount is the down payment on the proposed power facilities at the Hanford atomic energy plant. Ultimate cost of these facilities will run somewhere in the neighborhood of $100 million.

"Re-programming" of the Reclamation Bureau requests would allow the new Administration to plan and initiate construction on the Upper Colorado basin transmission network which is estimated to cost around $110 million. Other proposed transmission line starts in the "re-programming" are initial commitments for further extensive commitments.

Still to come in a supplemental request is a plea for funds to begin the California-Bonneville intertie, estimated by one report to cost $200 million.

Thus we see that the President's appropriations requests for power facilities could well blossom into commitments of over $490 million.

Inaugural for a New Cable Era

Next week's Extra-High-Voltage Cable Conference at Elmira and Ithaca, N. Y., holds opportunities few serious students of high-voltage underground cable development can afford to miss with impunity. Here, under the sponsorship of the Insulated Conductor Committee of the American Institute of Electrical Engineers, has been organized a forum and meeting place for some of the leading authorities on high-voltage cable research and development in the United States and Europe.

Coming at a time when field testing of experimental EHV cables is being started at the nearby Cornell University EHV Cable Testing Station, this conference will crystallize in one place, and at one time, the state of the high-voltage cable development both here and abroad.

- Experts from the leading European cable laboratories at KEMA in Holland, Fontenay in France, and Staythorpe in England will report on foreign field testing practice
- American authorities responsible for planning the Cornell Test Station will discuss the testing program planned, techniques to be used and cable and terminal systems involved in the field tests.

Portions of the program will be held at the Cornell Test Station built by the EEI and AEIC in cooperation with the cable industry to field test four experimental cables designed for 345 kv and 500 Mva. Over the next three years the test program will evaluate the mechanical, electrical and thermal performance of cable and accessories and lay the groundwork for extending present US underground cable practice into the EHV range.

Thus as we see it, next week's EHV Cable Conference is a fitting inaugural for the new era of high-voltage cable development in the United States—the era now just beginning.

Increased Power Activity Shows in

President Kennedy's revised budget request for fiscal year 1962 shows an increase of more than $100 million for power-related projects over the budget estimate sent to Capitol Hill in January by former President Eisenhower.

Most of this — $50-million— comes from an increase in rural electrification loan funds (EW, Mar. 27, p 20); another $30.1-million would be added to the Eisenhower budget for the Atomic Energy Commission; and a sizable chunk of money also is provided to speed up, or start, work on federal transmission lines by the Interior Department.

The new Kennedy budget revisions call for $60-million to convert the Hanford New Process Reactor, Wash., to power generation (650 Mw). Actually, the new money for Hanford is part of a $93.8-million increase in Kennedy's revised budget for AEC construction. But this will cost the taxpayers only $30.1-million more than the Eisenhower budget because Kennedy's revised budget cuts $63.7-million off the AEC's operation and maintenance allocation. The Kennedy request for AEC totals $2,628,150,000, compared with Eisenhower's request of $2,598,-050,000.

Interior Secretary Stewart Udall said in a Tuesday press conference that power generation at Hanford was "never regarded as an indispensable element" of the proposed Bonneville-California intertie, but the availability of 700,000 kw Hanford power "would make some type of intertie almost essential."

The proposed budget revisions indicate the placing of the federal foot in a number of new doors. The new budget can be summarized as an echo of President Kennedy's master-plan for power-related legislation: "**(1)** Federal regional and inter-regional transmission lines, **(2)** New construction starts for federal multipurpose projects, **(3)** A number of national and regional studies into power planning needs" (EW, Feb. 20, p 26-27).

Only REA, the Bureau of Reclamation and Bonneville Power Administration had significant changes in the two budget messages. In all three instances, President Kennedy asked for Congressional approval for more power facilities—but in the case of the Bureau, he said it could be done without increasing the Eisenhower budget request of $290,317,000.

Bonneville Power Administration's budget request for new construction was raised by $2,314,000 to a total of $18,020,000. Unchanged is Bonneville's budget request of $12,350,000 for operation and maintenance. This makes the total Bonneville budget for fiscal 1962, $30,370,000.

The added funds for Bonneville would be used to start work on five transmission lines. The five lines ultimately would cost $32,405,000. These lines and their '62 fiscal cost (and ultimate cost in parentheses) are: a single, 345-kv line between Portland and The Dalles Dam, $380,000 ($13-million); a single, 345-kv line from Seattle to the Canadian border, $425,000 ($10-million); two 230-kv lines to the Tillamook and Reedsport areas on the Oregon coast, $654,000 ($8,240,000); one 115-kv line from

Breakdown of Power-Related Budget Changes

Agency, Project	Eisenhower Budget	Kennedy Budget
Rural Electrification Administration		
Electric loan funds	$115-million	$195-million
Electric loan reserve funds	30-million	.....
Bureau of Reclamation Total	290,317,000	290,317,000
Colorado River Project transmission lines	8,673,000	14,503,000
Trinity - Central Valley transmission lines, Calif.	.....	5,000,000
Yellowtail Dam-Dawson County, Mont., 230-kv transmission line	.....	950,000
Keswick - Toyon, Calif., 115-kv line	.....	290,000
Curecanti Project, Colo.	4,557,000	5,229,000
Study of inter-regional networks	.....	300,000
General investigations	5,850,000	6,350,000

Agency, Project	Eisenhower Budget	Kennedy Budget
Bonneville Power Administration	15,706,000	18,020,000
Corps of Engineers total (No change in power-related projects)	931,700,000	948,700,000
Tennessee Valley Authority (Not for power facilities)	29,703,000	31,703,000
Atomic Energy Commission	2,598,050,000	2,628,150,000
Southwestern Power Administration (Construction, operation & maintenance)	2,260,000	no change
Southeastern Power Administration (Operation & maintenance)	800,000	no change
Federal Power Commission	8,793,000	no change

New Budget

Lebanon, Ore., to the Green Peter Dam site, $1-million ($1,165,000).

The Portland-The Dalles line is justified as necessary to heavy up present overloaded circuits. Eventually it would be extended eastward to John Day Dam. The line also probably would be used as a major connection with the proposed Bonneville-California high voltage intertie. The Seattle-Canada line would connect with British Columbia Electric Co, but would also be used later to wheel power back to Canada, as part of her share in the treaty development of the Columbia River.

Bureau Funds Are Reshuffled

The changes in the Bureau of Reclamation's budget call for a number of new, federal transmission lines to be started. By "re-programming" the same funds asked for earlier by former President Eisenhower, the Kennedy Administration feels it can start these added projects without cutting back any other projects. Still in the Kennedy budget are the five new construction starts recommended earlier by the Eisenhower Administration.

The proposed new transmission lines would be: a 230-kv line between Cottonwood and Tracy, Calif., to carry Trinity-generated power into the Central Valley system, $5-million; an eight-mile, 115-kv line between Keswick and Toyon, Calif., to increase federal power deliveries to the Shasta area public utility district, $290,000; a 230-kv line from Yellowtail Dam to Dawson County, Mont., to interconnect the eastern and western divisions of the Missour River project, $950,000; a total of $5,830,000 (on top of Eisenhower's earlier request of $8,673,000) for completion of planning and start of construction on a number of lines in the upper Colorado project area: Gunnison-Curecanti-Montrose, Glen Canyon-Phoenix, Vernal-Provo No. 1, Craig-Sinclair, Glen Canyon-Sigurd-St. George, Four Corners-Albuquerque, Curecanti-Midway, Curecanti-Rangely.

The final group of lines are proposed to be built by the Bureau, following the recent recommendations by both former Interior Secretary Fred Seaton and new Secretary Stewart Udall in favor of federal lines—instead of a plan for privately built lines proposed by five Mountain states utilities. The federal lines will be fought by these companies in the coming hearings by the House Appropriations Committee—probably in mid-April.

The "re-programming" of Reclamation funds also has made room for an added $672,000 (on top of Eisenhower's $4,557,000 request) to hurry up construction of the Curecanti project, Colo., continue work on Blue Mesa Dam and start work on Morrow Point Dam and power plant.

The network intertie study ($300,000) and an added $500,000 (to Eisenhower's previous $5,850,000 for general new projects investigations) completes the changes in the new Reclamation budget request.

The $50-million increase for REA electric loan funds is part of a total $100-million increase requested for REA, the other $50-million going for telephone loan funds. Actually, the REA electric loan fund would be increased $80-million, because the previous $30-million reserve fund, asked by Eisenhower, would be added into the general loan funds without special designation. This makes the total new appropriation for REA loans $195-million. Another $30-million in unused loan funds from previous years, and canceled loans, makes the actual funds available for REA loans approximately $225-million.

Several Projects Not Mentioned

Not mentioned in President Kennedy's budget request are funds to start work on Libby Dam, Mont., the Fryingpan-Arkansas project, Colo., or the proposed federal Bonneville - California intertie. Funds are expected to be asked for these, either in supplemental budget requests for fiscal 1962, or in coming budget messages, as the projects are authorized for construction. Libby requires ratification by Canada of the US-Canadian treaty.

News Scope

PILFERAGE—Tens of thousands of dollars worth of machinery and supplies have vanished from the $720-million Niagara power project since work began in 1958. The looting resulted from failure of project contractors to keep complete warehouse inventories, authorities said. One ring, broken by police, had taken $16,000 worth of material including a trailer loaded with steel valued at $7,000. There have been several arrests but, police acknowledge, not nearly as many as there should be.

TURNABOUT—American & Foreign Power Co, once among Mexico's biggest power suppliers, is now one of the country's biggest users. A&FP has purchased a 14% interest in a $16.5-million aluminum plant to be constructed in Vera Cruz. The plant will get its power from the Tamascal hydroelectric project. When A&FP sold its Mexican utilities to the government last year it promised to re-invest the $73-million price in Mexico. Partnership in the aluminum plant is such an investment. Alcoa has a 35% interest in the project with Mexican industrialists holding a 51% interest.

CHANGE OF PLANS—TVA's 900-Mw Edgemore steam plant unit will operate at super-critical pressure of 3,500 psi instead of previously announced 2,400 psi (EW, Mar. 27, p 76). Operating speed has also been changed to 3,600/1,800 rpm from 1,800/1,800. Steam will be at 1,000/1,000F instead of 1,050/1,000F. TVA representatives said further evaluation by TVA, GE, and Combustion Engineering led to the new figures.

NEW NAME—The National Industrial Service Assn, Inc, has changed its name. Since Apr. 1, it has been known as the Electrical Apparatus Service Assn, Inc. EASA is an international trade group of companies in North America which service electrical equipment.

- Stainless steel components crack in three reactors
- Fourth is questionable because of similar material
- Substitute components are installed in Dresden plant

Alloy Fails in A-Plant Reactors

Uncertainty over the reliability of 17-4-PH stainless steel nuclear reactor components is assuming major proportions at the Atomic Energy Commission.

AEC's Division of Licensing & Regulation, in the most recent of several safety actions stemming from discovery of 17-4-PH materials defects in boiling water reactors, has refused General Electric Co permission to operate its boiling water testing reactor at Vallecitos, Calif.

GE advised the Commission on Feb. 8 that VBWR had been shut down to determine whether the reactor had the same sort of difficulties experienced last November by the 180-Mw Dresden BWR operated by Commonwealth Edison Co. Dresden had cracking problems in its control rod blades and control rod drive index tubes.

Four long corrosion-stress cracks were also detected at Vallecitos in one control rod shaft at a point outside the reactor vessel. It was admitted that failure of control rod shafts, above the seals, in the safety review sent to AEC by GE, could allow a control rod to be driven out of the core by steam pressure.

Different Alloy Proposed

GE advised that the shafts would be replaced by Type 304 stainless steel parts and that four lower grid 17-4-PH hold-down studs would be provided with Type 304 back-up supports. All other 17-4-PH parts, according to GE, would be replaced with austenitic stainless steel.

The changes were not considered by GE to involve an "unreviewed safety question." This factor would have allowed the Vallecitos reactor to start up again and proceed with commercial test operations under the terms of its AEC operating license.

But a recent Commission order signed by Harold Price, director of licensing and regulation, read:

"The recent discovery of cracks in precipitation hardened stainless steel components in the control rod drive systems of the Common-Wealth Edison reactor at Dresden, the Experimental Boiling Water Reactor at Argonne National Laboratory, and the VBWR has indicated the need for a detailed review of the design, fabrication procedures, and inspection of such components to determine their suitability for reactor service. Accordingly, General Electric is hereby ordered to submit to the Commission the information listed below and not to resume operation of the VBWR until authorized by the Commission following evaluation of such information."

GE Must Supply Information

The material to be submitted by GE must cover all material and component fabrication for precipitation hardened stainless steel items in the VWBR reactor, including assembly-sectional drawings and a full discussion of the basis for GE's belief that design changes and material substitutions in VBWR are adequate. An independent laboratory will also be asked by AEC to evaluate 17-4-PH problems and the adequacy of suggested remedies.

The Advisory Committee on Reactor Safeguards recently reviewed safety features involved in the use of 17-4-PH stainless steel in both the Dresden and Elk Rivers reactors. Its conclusion was that proposed modification and technical reviews now underway would result in adequate precautions to allow safe operation of both reactors.

ACRS says GE has improved Dresden control rod drives by removing all 17-4-PH stainless steel which has been aged at temperatures below 1,000F, and replaced this material with the same alloy which has been fabricated and heat treated by an improved procedure. Periodic inspection will be necessary to assure that any cracks or failures that occur during operation will be detected as promptly as practicable, ACRS added.

The Experimental Boiling Water Reactor (EBWR) at Argonne also experienced cracks in precipitation hardened stainless steel components in its control rod drive systems. EBWR was down for modifications to increase thermal capacity (originally designed to operate at 20 Mw) to 100 Mw when the cracks were discovered. Full power operation will not begin until the stainless steel problems are resolved. Operation at the higher power level is to test stability limits of small natural circulation BWR's with cores of greater power densities than previously used.

The recent hearing on the Elk River 22-Mw boiling water reactor showed that AEC's attitude on starting up this plant included a number of safety questions concerning stainless steel components being used in the reactor. AEC's staff attorney in the hearing said that Allis-Chalmers Manufacturing Co would have to provide a complete report of safety problems which could result from 17-4-PH stainless steel parts in the reactor. Then he said Allis would have to come up with an acceptable program to remedy the situation. He indicated there was some thinking that the precipitation hardened control rod stainless steel parts which had been pre-heated under 900F would better satisfy their requirements if preheated to 1,100F.

Allis-Chalmers is now considering whether to ask Alco Products, which built the control rod system, to re-fabricate all the safety control parts that have 17-4-PH materials.

Arthur Gehr, attorney for Commonwealth Edison, in the meantime, has asked AEC for permission to conduct limited tests on Dresden (at 100-Mw level) with the new components. There were no objections to the proposal at press time.

Thunder Bay Turbine Built in Canada

Manufacture of a 100-Mw turbine within its own borders may be start of new era in Canada's electrical industry

The first Canadian-built steam turbine designed for electric power generation goes on the line in October. Coupled with a British generator, the turbine will produce 100 Mw at Ontario Hydro-Electric Power Commission's Thunder Bay Station at Fort William.

The turbine signals the advent of a new Canadian industry for both domestic and export trade. About 85% of the work on the unit is being done in Canada, according to spokesmen for the manufacturer, John Inglis Co. The rotor forging was imported from Italy, and the 27-in. blades of high tensile steel from Britain. Practically all other parts were obtained in Canada and machined at the company's Scarborough plant in Toronto.

Expansion May Take Place

While one turbine doesn't make an industry, there are clear signs that both the Canadian government and the English Electric Co, owner of the John Inglis Co, are planning to expand the operation.

First is the change in the country's tariff regulation put into effect in December. Previously, turbogenerators had been imported from Great Britain and continental Europe duty free. But in December the Canadian government amended import legislation so that machinery of this type made in Canada would enjoy tariff protection of 15% over imports from Commonwealth countries, and 20% over other favored nations.

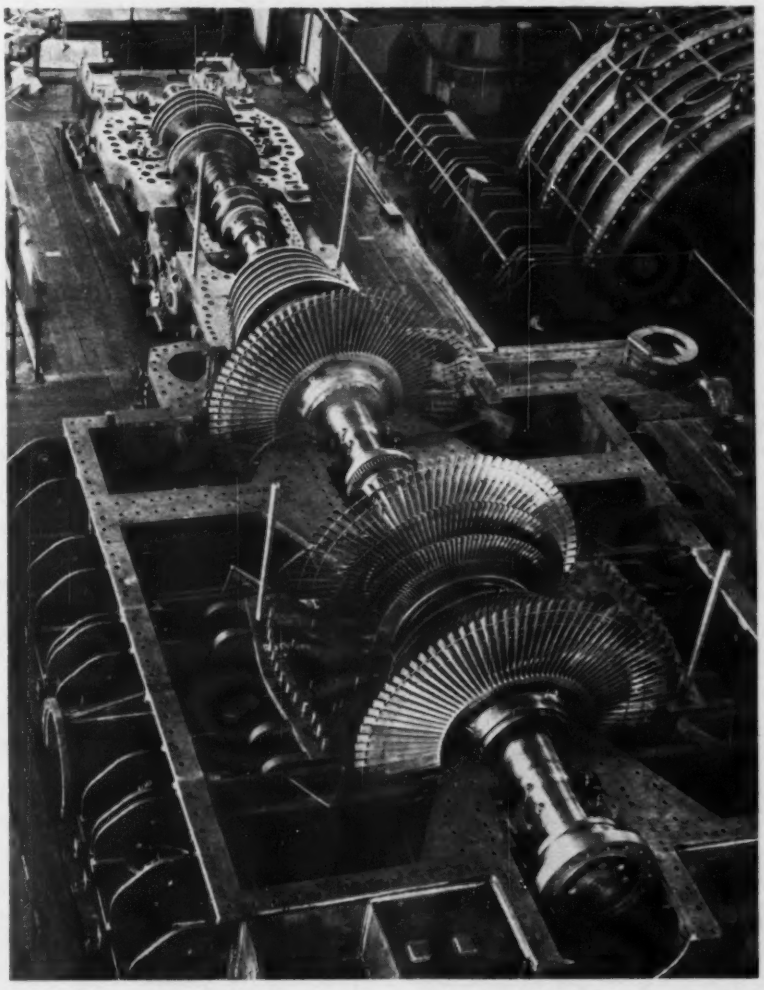
Secondly, there is the investment by Inglis of more than $1 million in test equipment and special machinery to make the 100-Mw Thunder Bay unit. Such an investment certainly anticipates further orders from Canada and other nations.

Finally, there are plans to have Canadian Westinghouse Co Ltd, of Hamilton, Ontario, manufacture components presently imported. For the 100-Mw Thunder Bay unit, the generator, exciter, and several other components were made by the English Electric plant at Rugby, England. In the future Canadian Westinghouse will supply this equipment. Boilers for Thunder Bay were made by Foster Wheeler Ltd at St. Catherines, Ontario.

The turbine will take steam at 1,450 psi, 1,000F, with no reheat. Rotors were recently tested at the Inglis Toronto plant in a specially built vacuum box that simulated actual operating conditions. Designed to operate at 3,600 rpm, the rotors were run as high as 4,300 rpm.

With its new facilities established, Inglis is now prepared to build two 300-Mw steam turbogenerators for Ontario Hydro-Electric's new steam plant at Lakeview.

When Thunder Bay goes on the line in October it will mark another first in Canadian power development. Abundant water power has been the main source of electricity in Canada. West of the Great Lakes, it has been the sole source of power. But now the country's industrial complex is requiring even greater quantities of electricity, and in Ontario there is now some need for supplementing hydro with steam power. Thunder Bay is a first step in this direction. It's the first Canadian steam plant to be built west of the Great Lakes.



TURBINE built by John Inglis Co being readied for shipment to Thunder Bay

Utilities Laud Progress of MHD Unit

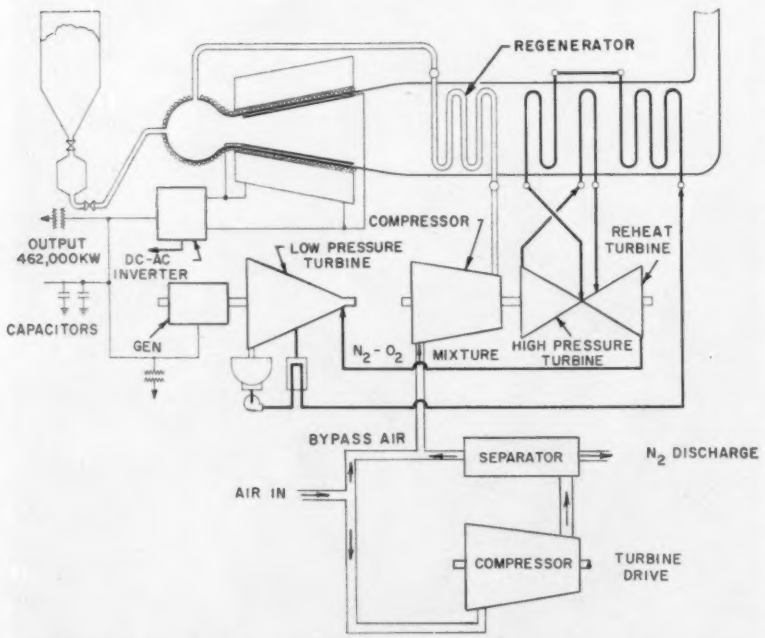
Mark II generator developed by Avco and ten utilities promises efficient, commercial MHD power in the future

Prospects for commercial power generation without heavy rotating equipment advanced significantly when a magnetohydrodynamic (MHD) generator produced 205 kw. The experimental unit, called the Mark II, was developed by Avco Corp in conjunction with ten investor-owned utilities. Avco estimates that the first commercial MHD plants could be as much as 40% more efficient than existing plants.

Main purpose of the large-scale experimental Mark II is to evaluate engineering problems connected with generation by the MHD principle. So far, results have been encouraging. In generating 205 kw, the unit exceeded by 20 times the power output achieved in 1959 when Mark II began operating. Dr Arthur Kantrowitz, Avco vice president and director of the company's Everett, Mass., laboratory where the research has taken place, said the generator, after further development, will be capable of producing better than 500 kw for the time periods necessary to evaluate engineering problems associated with the system.

The Mark II operates for periods of up to one minute, which is more than adequate for the necessary studies. Long duration tests of generator components can be conducted on a smaller scale.

The basic principle of the MHD generator is the same as that of a conventional generator. An electrical conductor moving through a magnetic field generates a voltage. But where the conventional generator uses a solid conductor moved through the field by a turbine, the MHD device puts a stream of ionized gas (called a plasma) through the field. The turbine, therefore, is unnecessary.



PROPOSED HEAT CYCLE uses MHD generator's exhaust (top center) to pre-heat compressed air enroute to combustion chamber. Remaining heat in exhaust produces superheated steam to drive compound turbine coupled to air compressors. MHD generation is supplemented by alternator on l-p unit's shaft

Speaking for the ten utilities which originally joined Avco in MHD power studies, and for two additional electric companies which have just become part of the project, American Electric Power Co President Philip Sporn called MHD "probably the most exciting area of development in power generation today. This program," he said, "has yielded results more favorable than we could have reasonably expected at the end of 1959." Sporn added, "The studies continue to affirm that the MHD power system promises considerably higher efficiency at reasonable capital costs."

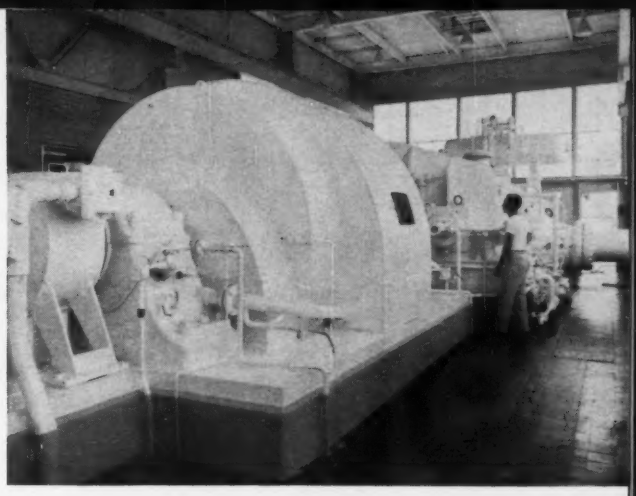
Problem Solved

Dr Kantrowitz believes the Mark II has solved one of the major problems facing commercial use of MHD generators. This is the problem of material versus temperature. Temperatures in excess of 4,000F are necessary to ionize the combustion gases. Avco's original cycle called for preheating the combustion air to better than 3,000F but there were no materials available which could withstand such temperatures. To solve the problem, Avco and AEP studied power cycles where the combustion air is enriched with oxygen before it goes into the preheater and combustion chamber. This reduces preheat requirements to the point where a conventional material such as stainless steel can be used, meaning that preheaters now available will fit into the MHD system.

Many other aspects of the generator are under study, including various schemes for converting the unit's dc output to ac. At present, simple inverters appear to be the most feasible means of creating ac, but some consideration has been given to making the generator produce ac directly.

In the Mark II, a combustion chamber similar to a rocket thrust chamber supplies the plasma, or hot gas. The chamber burns a mixture of kerosene or alcohol and gaseous oxygen "seeded" with powdered potassium salts to make the plasma a better conductor. Plasma enters the generator at about 5,000F.

Industrial Electrical Systems



On these pages, Electrical World *publishes its survey of compressor-drive motors* 3,000 *hp and larger and reports on three distinct aspects of electrical-system modernization in three industries: a program for relays in a refinery (over-leaf), an* 8,000-*kw rectifier for a steel-mill drive (p* 41*), and expansion of the electric system in the cement plant seen on the cover (p* 46*)*

Very Large Ac Motors Prove Dependable

Continuity of utility power supply also cited by users as favorable to large units

Reliability of equipment and electricity supply are leading spurs of a trend of the last half dozen years toward ac motors of several thousand horsepower for compressor and blower drives. Economy of these units was also cited by very-large-motor users who responded to an *Electrical World* survey.

In telling their willingness to put many eggs in one basket, users were in general agreement on several points.

- Reliability of motors and driven equipment was high among the decisive reasons for going to these very large motors. The driven units in all but a few cases were compressors.
- All users replied that they have put in these installations without spare units.
- Service experience, very good or trouble-free in all cases, has proved the validity of the choices.
- Most users do not feel it necessary to run alternative sources to these motors. Those who do also have automatic transfer to the standby sources.
- Continuity of the utility company's service was also a decisive reason favoring installation of large units. A majority of the plants have more than one utility service connection. None generates its own electricity. These plants are refineries, gas pumping stations and chemical works.

Besides mentioning economy of large installations as a major reason for putting them in, the users pointed out that they expect to run them for extensive periods between scheduled shutdowns. The most often listed period was 24 months, though others cited intervals of 12 to 36 months.

Across-the-line starting is the practice of all users, who said they had readily got permission from the utility companies for such operation. No problems were cited.

Types and sizes of the 35 big motors covered in the survey are summarized below. The largest units reported, seven 15,000-hp synchronous motors, drive centrifugal gas compressors for a gas pipeline. One is shown above. The largest induction motor was a 9,000-hp unit.

Summary of Electrical World's Motor Survey

Sizes of 35 Motors in Plants Surveyed		Types		Loads		Installation Dates	
3,000– 4,900 hp	11	Synchronous	17	Compressors	32	1954	4
5,000 hp	9	Induction	18	Blowers	3	1955	5
5,100– 9,900 hp	6					1956	3
10,000–14,900 hp	2					1957	8
15,000 hp	7					1958	9
						1959	4
						1960	2

Program Assures Reliable Relay

Mobile relay test unit and training program for plant electricians help them maintain the relays at refinery

B. E. CRAWFORD, L. J. VIRGILLIO*, Mechanical Engineering Dept, Baton Rouge Refinery, Humble Oil & Refining Co, Baton Rouge, La.

Correct relay settings and coordination for an entire refinery distribution system are maintained through a comprehensive program that has yielded a decrease in the number of incorrect relay operations, hence a drop in equipment outages. The program instigated at the Baton Rouge Refinery of Humble Oil & Refining Co, which has a demand of 90 Mw, raised relay setting from a rule-of-thumb practice to the engineered level. It embraces three phases: engineering procedures, field procedures and follow-up.

Formerly, relay settings were made by the refinery electricians, who set each relay pickup above full-load current and adjusted the time dial so that the relay would not trip in normal operation. They kept no records of their settings. Outside consultants assisted in making the settings at the supply voltage, 13.8 kv. Growth of the plant load and increased complexity of the system, which was redesigned into a 13.8-kv network, called for a new method of assuring over-all relay coordination.

A systems engineer led off the new program with a relay coordination study of the complete system.

*Since preparation of this paper, Mr Virgillio has left the employ of Humble Oil & Refining Co and now is affiliated with Gregory Salisbury & Co, Inc.

ELECTRICAL DISTRIBUTION SYSTEM RELAY SETTINGS RECORD

ORIGINAL ISSUE 4-15-58 BY L. J. Virgillio PHONE 294
LATEST ISSUE BY PHONE
CHANGED PANELS
FIELD TESTED BY

STATION O-10 VOLTAGE 2400

FEEDER NUMBER	SERVICE	CT OR PT RATIO	RELAY DESCRIPTION: MANUFACTURER & TYPE	STYLE	ASA SYMBOL	CHAR #	GANGE: TIME	GANGE: INST.	CURVE	NOMINAL SETTING: TAP & (PICKUP)	TIME LEVER	INST	CALIBRATION: TIME SEC.	CALIBRATION: VOLTS AMPS	CHECK POINT: TIME SEC	CHECK POINT: VOLTS AMPS	ALLOW. ABOVE VOLTAGE FOR TIME %	TEST VALUES: CALIBRATION TIME SEC.	CALIBRATION VOLTS AMPS	CHECK POINT TIME SEC.	CHECK POINT VOLTS AMPS	REMARKS
O10X3	600 HP Motor	200/5	W-BL-1		49M/50M	L	2.5-5.0	20-80	-	3.0		35	37	18	480	6					
	PCLA-3 Cooling		W-BL-1		49M/50M	L	2.5-5.0	20-80	-	3.0		35	37	18	480	6					
	Tower		GE-IAC	12IAC66C4A	50M/51M	B	4-8	20-80	CX6	6.7(6.9)	2	35	33	32.5	8	13.4					
O10X4	750 KVA Transformer - PCLA-3	400/5	GE-IAC	12IAC77B4A	50/51	F	4-16	20-80	710.1	10 (10)	2	80	19	70	2.7	20					
			GE-IAC	12IAC77B4A	50/51	F	4-16	20-80	710.1	10 (10)	2	80	19	70	2.7	20					
	Cooling Tower		GE-IAC	12IAC77B4A	50/51	F	4-16	20-80	710.1	10 (10)	2	80	19	70	2.7	20					
O10X5	CLA Area	400/5	GE-IAC	12IAC77A1A	51	F	4-16	-	710.1	12(12.5)	10	-	1.5	62.5	17	25					
			GE-IAC	12IAC77A1A	51	F	4-16	-	710.1	12 (12.5)	10	-	1.5	62.5	17	25					
			GE-IAC	12IAC77A1A	51	F	4-16	-	710.1	12 (12.5)	10	-	1.5	62.5	17	25					
O10X6	Incoming Line	3000/5	GE-IAC	12IAC53D1A	50-1/51-1	E	4-16	10-40	710.2	6 (6)	3.5	Disc.	.49	60	4.6	12					
	No. 1		GE-IAC	12IAC53E1A	50-1/51-1	E	"	"	710.2	6 (6)	3.5	Disc.	.49	60	4.6	12					
			GE-IAC	12IAC53B1A	50-1/51-1	E			710.2	6 (6)	3.5	Disc.	.49	60	4.6	12					
		2400/120	GE-IAC	12IAV54E1A	27-1	I	55-140	-	-	93	2		12	0	6.1	84					
		2400/120	GE-PJV	12PJV11L21A	27I-1	G	-	70-160	-	(105)		95	100	Volts	Drop	OUT					
O10X7	N-11 Substation	500/5	GE-IAC	12IAC77B4A	50/51	F	4-16	20-80	710.1	8 (8)	4	80	.35	56	5.5	16					
	Feeder--1500		GE-IAC	12IAC77B4A	50/51	F	4-16	20-80	710.1	8 (8)	4	80	.35	56	5.5	16					
	KVA (North)		GE-IAC	12IAC77B4A	50/51	F	4-16	20-80	710.1	8 (8)	4	80	.35	56	5.5	16					
O10X8	1000 HP North	300/5	GE-IAC	12IAC66C4A	50M/51M	B	4-8	20-80	CX6	7.1 (7)	2	40	3.3	35	8	14					
	Motor - PCLA-2		W-BL-1		49M/50M	L	2.5-5.0	20-80	-	3.2		40	34	19.2	480	6.4					
	Cooling Tower		W-BL-1		49M/50M	L	2.5-5.0	20-80	-	3.2		40	34	19.2	480	6.4					
O10X9	No. 3 DAS	400/5	GE-IAC	12IAC77A1A	51	F	4-16		710.1	8 (7.5)	10	-	1.2	52.5	17	15					
			GE-IAC	12IAC77A1A	51	F	4-16		710.1	8 (7.5)	10	-	1.2	52.5	17	15					
			GE-IAC	12IAC77A1A	51	F	4-16		710.1	8 (7.5)	10	-	1.2	52.5	17	15					
Motor Undervoltage Bus 1		2400/120	GE-IAV	12IAV54K1A	27M	I	55-140	-	-	82	8		4.1	0	9	60					

*CHARACTERISTIC
A Short time (inverse)
B Long time (inverse)
C Definite minimum time inverse
D Inverse time
E Very inverse time
F Extremely inverse time
G Instantaneous
H Inst pickup time dropout
I Time undervoltage
J Time overvoltage
K Time undervoltage-overvoltage
L Thermal inverse time
M

FILE NO. O-10 - 1

CALCULATED RELAY SETTINGS entered on the Relay Settings Record by plant engineers appear as nominal settings. Electricians set the relays, test their settings for accuracy, and enter test values on the Record, which is filed

Settings

He also held the responsibility of making system changes required for a coordinated relay system. A major result was a design manual giving criteria for setting relays. With it as guide, each engineer determines the relay settings for his own jobs, then reviews them with the systems engineer to ensure that they fit into the over-all system coordination.

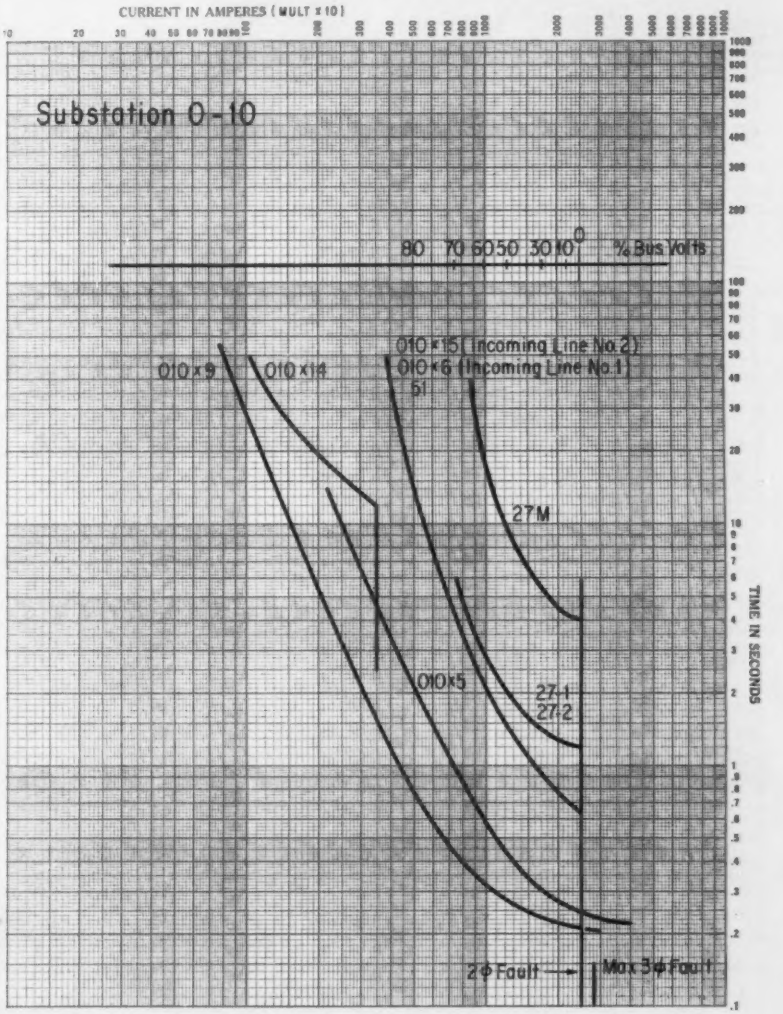
The chief aim is to minimize process-equipment outages by having the circuit-clearing device nearest a fault open to clear it, while the back-up breakers and fuses remain closed and continue to carry current to unaffected loads. Also, the relaying system restores distribution-bus voltages when these buses lose their supplies. If the feeder to a distribution bus or supply to that feeder fails, a control device automatically closes a tie breaker to another live bus. But if the loss of voltage is due to a fault on the distribution bus itself, this automatic operation does not take place.

MOBILE RELAY TESTER designed and built by the engineering department checks settings of most switchgear-type relays for industrial power systems

Design Manual Specs

The design manual specifies relay types and settings for breakers on four kinds of feeders: motor, general purpose, out going transformer and incoming feeders. Each breaker is equipped with an induction overcurrent relay on each phase and, for grounded-neutral circuits, on the neutral, plus auxiliary relaying where appropriate, as shown in the table. The design manual specifies in detail current, voltage and time settings for the various relay elements. The timing-element current settings are specified in percentages of full-load values, current instantaneous settings are generally in percentages of maximum fault currents, and voltages, in percentages of rated potentials.

On automatic transfer of a motor feeder, some motors ride through


CURRENT IN AMPERES (MULT x 10)
Substation 0-10
80 70 60 50 30 10 0 % Bus Volts
0 10 x 9
0 10 x 14
0 10 x 15 (Incoming Line No. 2)
0 10 x 6 (Incoming Line No. 1)
51
27M
0 10 x 5
27-1
27-2
2 ϕ Fault
Max 3 ϕ Fault
TIME IN SECONDS

COORDINATION CURVES for one substation show incoming feeder relays are set slower than outgoing. Voltage scale applies for transfer relays, 27's

the transfer while others are tripped out by a transfer relay (ASA symbol 83). Those tripped out are re-energized manually.

Relay Settings Engineered

Relay types are specified on each switchgear order, but, before returning approval drawings, the engineer determines the relay settings to be sure the relay types are satisfactory for the particular applications. A record of these settings and the engineer's calculations for determining them are filed by substation number. The columns headed *Nominal Setting* on the sample partial record shown list his computed values. This file also includes a one-line diagram of the substation and a set of coordination curves for all its relays. These coordination curves can usually be made simply by tracing onto a common sheet (K&E No. 336E) the relay and fuse curves for that substation because manufacturers now furnish most characteristic curves on log-log paper of the same scale.

The project engineer issues the settings record to the plant electricians when the construction drawings are issued to initiate the field phase of the program. The electricians who make the settings enter the test values in the columns provided after they have set and tested the relays. They test the accuracy of these settings yearly.

Check Test Values

The engineer follows up by checking the record to be sure that the test values are correct within tolerances. They check discrepancies against the coordination curves. If proper coordination is obtained even though the test values are not within tolerances, no corrections are made. The design manual states the following:

"For proper coordination of two relays, the minimum operating time differential should never be less than 0.35 sec at maximum short-circuit current. For coordination of a relay with a fuse, the relay may be set a minimum of 0.25 sec above the total clearing time of the fuse."

If proper coordination is not obtained, the relays are adjusted until the settings are acceptable or new relays are installed which provide coordination.

To assure that relays are properly set, a mobile relay test board was designed and built, a training program was established to teach electricians relay test and maintenance procedures, and a maintenance schedule was set up for checking every relay once a year.

Tests Most Relays

The relay test board, which was designed and built by the refinery's engineering department, can be used in setting most of the switchgear-type relays found in an industrial distribution system. It can furnish alternating current with good wave form of 0-30 amp continuously and 30-100 amp for periods long enough to make relay settings requiring these currents. A second source of ac is available for checking differential and directional overcurrent relays. The relay test board can also furnish direct current to 3 amp.

Feeder Purpose Determines Relay Type for Breakers

	Phase relays			Ground relay			
Feeder	Time characteristic	Instantaneous trip	ASA symbol	Time characteristic	Instantaneous trip	ASA symbol	Other relaying
Motor feeder	Long	Yes	50M/51M	Short	Yes	50N-M/51N-M	Undervoltage relay with inverse-time characteristic, 27M, for automatic transfer plus auxiliaries
General purpose feeder	Very inverse	No	51	Inverse	No	51N	Automatic reclosing
Outgoing transformer feeder	Extremely inverse	Yes	50/51	Inverse	Yes	50N/51N	None
Incoming feeder	Very inverse	Yes*	50/51	Inverse	No	51N	Indurtion time, 27, and instantaneous, 27 I, undervoltage relays for automatic transfer*

* On incoming feeder, instantaneous-trip elements, 50, of phase relays do not trip breaker but only block transfer on bus fault. These elements disconnected if coordination obtained between timing elements, 51, and undervoltage relay, 27.

FIG 1—**RECTIFIER** was assembled in four sections of 24 ignitrons each for ease in fitting space

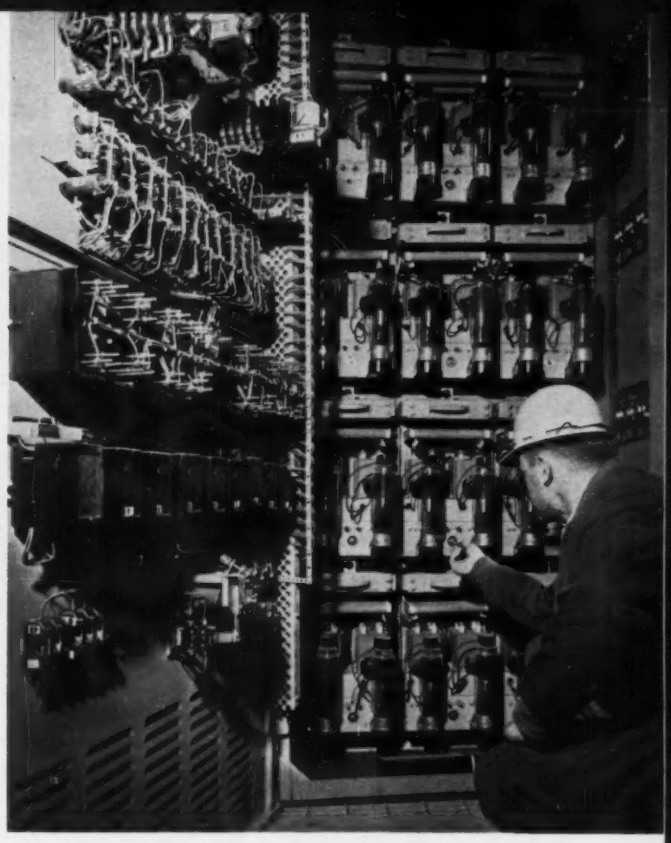


FIG 2—**THYRATRONS** of one rectifier section fire ignitrons. If one fails, another in parallel still operates

Industrial Electrical Systems

Back-to-Back Rectifiers Supply 10,000-Hp Drive for Steel Mill

Ignitron assemblies fitted into available basement space; flicker on the utility substation kept within limits

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A power supply for a steel reversing mill utilizes back-to-back rectifiers that allow the mill motors to regenerate without reversing the motor armature leads or the motor field, thus overcoming one of the major objections to a rectifier-powered reversing drive. The rectifier has been supplying a 10,000-hp, 140-in. reversing plate mill with an edger at Lukens Steel Co for nearly two years.

Designers of the system placed emphasis on reliability. Important circuits are carefully monitored for quick trouble shooting. Misfires of the main power tubes or the thyratrons that fire them are monitored by misfire lights. Arc-backs in the rectifier are also monitored by indicating lights.

Because rectifiers can be shoehorned into space that might be otherwise wasted, at Lukens valuable floor space that would have been used by a conventional motor-generator set was left free for loading slabs. This space has extra value since it is under a high-capacity crane, for which a good service factor is now realized.

Significant control features on the mill include high rate of acceleration and deceleration and fast reversal time obtained with a high-gain, fast-response voltage regulator, a rate-of-change-of-voltage regulator with overriding current limit, and a current-rate limiter, which prevents acceleration and deceleration currents from changing at rates greater than the dc motors can commutate.

This reversing hot mill is required to break a 60,000-lb ingot down to slabs for further rolling by a finishing mill and to roll the slabs into plate. To roll the steel before it cools, the mill must be capable of fast reversals. This mill reverses from base speed to base speed in 1.5 sec and from top speed to top speed in 4 sec. A typical schedule takes about 2 min to roll 21 passes, including two interruptions for edg-

ing passes and turning the slab broadside.

Because metal is never reduced in the main mill and edger at the same time, the main rectifier is also the power supply for the edger, which is switched on only for the edging passes. The edger is about 30 ft from the main mill. As is typical of reversing mills, the motors have high peak-torque ratings of 225%, frequently repeated (every ingot), and 275%, occasionally repeated. This intermittent operation allows the motor loadings figured on an rms basis to approach the motor ratings.

Motors Integrally Cooled

The main drive consists of two 5,000-hp, 40/80-rpm motors, which are integrally cooled and require only a small amount of make-up air. This obviates a specially ventilated motor room adjacent to the mill. The motors have an inverted twin arrangement. The top roll is driven by the front motor, the bottom roll by the rear motor. The edger motor, rated 3,000 hp, 70/175 rpm, is also integrally cooled.

Electrically, the back-to-back rectifier comprises four sections, each containing 24 tubes. As the schematic (Fig 3) shows, each two of these sections are fed from a 12-phase 5,030-kva transformer selected to match the motor rating. The rectifier is rated 8,000 kw, 750 v dc. Its peak overload ratings match the main drive motors: 225% maximum current, frequently repeated (every ingot), 275% maximum current, occasionally repeated. For starting, stopping and reversing, 100% voltage control is available. Rated dc voltage is maintained under 95-110% rated ac voltage at light loads or at 175% rated current.

Each phase of the rectifiers utilizes two sealed ignitron tubes in parallel. These tubes can commutate high currents (interrupt conduction on passing through current-zero) and have been designed for high values of phase control without arcing back. The grids of these ignitrons are pulsed to assure accurate control of the start of anode conduction and reliability at large angles of phase retard. The rectifier tubes are fired by thyratrons arranged so one thyratron can fire both the parallel rectifier tubes (Fig 2). In case one thyratron fails, another in parallel still fires both tubes.

Pulsing also permits suppression of the ignitron firing during fault conditions. Grid suppression is applied to all the tubes in the rectifier for a few cycles whenever there occurs an arc-back or a phenomenon known as shoot-through, to which back-to-back rectifiers are subject. This happens when one phase of the power tubes fails to commutate and continues conducting until a breaker opens the circuit. A shoot-through usually happens only while the motor is regenerating and the rectifier is inverting. These conditions exist when the motor is reversing and when metal is normally out of the mill.

Cathode Breakers Cut Cost

The rectifier section involved in an arc-back or shoot-through stays suppressed for a few seconds during which one of the two cathode breakers in this section opens. After grid suppression is removed, the cathode breaker recloses. The eight cathode air circuit breakers are single-pole, stationary-mounted units with forward overcurrent and reverse-current trips and electrically operated closing mechanisms. This fault-protection arrangement, which is in contrast to the usual steel-mill practice of furnishing anode breakers, effected a substantial capital saving because the ratio of anode breakers required to cathode breakers would have been six to one in this rectifier circuit.

An arc-back or shoot-through does not shut down the mill. Fig 4, a slow-speed Brush recording of an arc-back, shows that arc suppression was applied and removed in approximately 4 cycles, a cathode breaker in the faulted rectifier section opened and the parallel section carried the load while the pass continued. At the end of the pass, the cathode breaker closed automatically. The operator did not know that an arc-back had occurred.

To accommodate the space available, the rectifier system was built in sections. The power rectifiers and excitation cubicles are located on a platform in the basement in one line. Each rectifier section con-

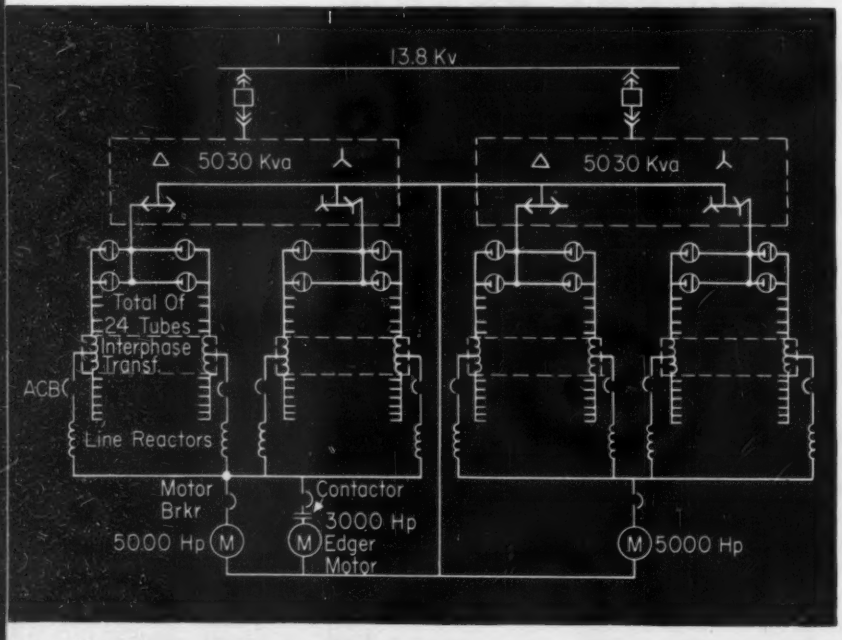


FIG 3—TRANSFORMERS are each 12-phase with four ignitron tubes per phase, two of these paralleled to each interphase transformer

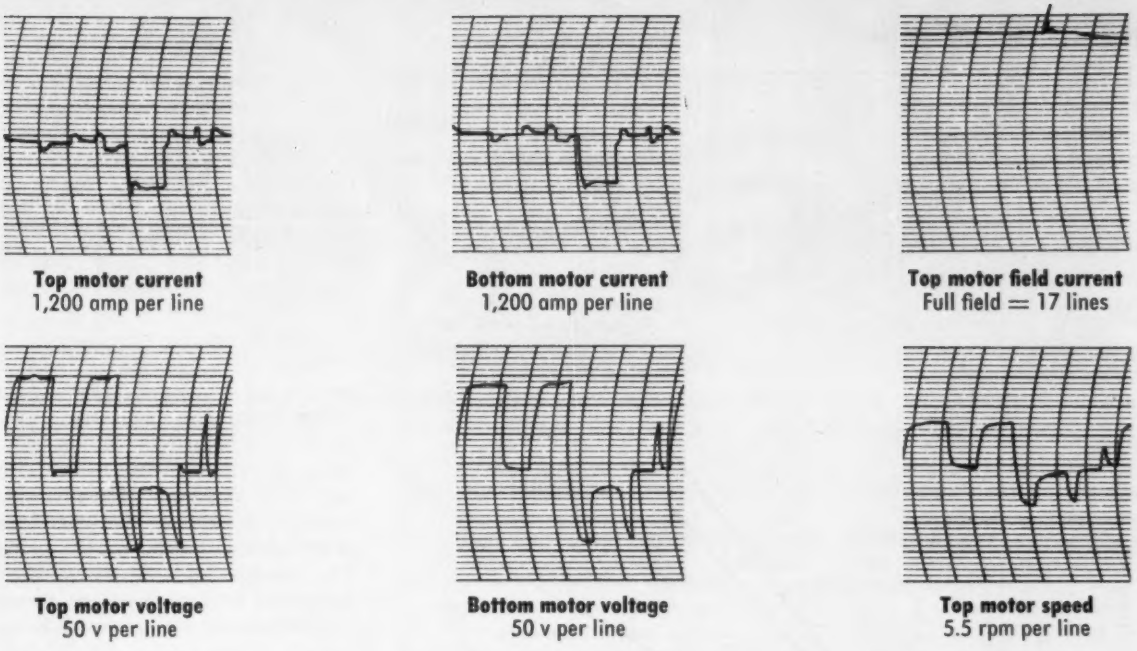


FIG 4—**BRUSH RECORDING** of arc-back in one rectifier section shows rapid recovery. Mill operation was unhindered

taining 24 tubes and its excitation cubicle were built as a unit for ease in handling. Fig 1 shows one half of a rectifier section. The heat exchangers, which are part of the rectifier cooling system, are located underneath the rectifier platform. The interphase transformers, the cathode breakers and the line reactors are on the basement floor. The main power transformers are outdoors. Where space permits, a rectifier system can be built into a complete package with all units in one line.

Bus Design Flexible

When this mill first went into operation, it utilized a split-bus arrangement for the top and bottom motor armatures. After operating in this fashion for about a year, it was decided to go to a common-bus arrangement. It is not the purpose of this article to decide the advantages of either arrangement. The choice between arrangements should be based on such factors as the fault duty imposed on the breakers, diversity between the rectifier sections and operating conditions. From the standpoint of rectifier performance, either arrangement will give satisfactory operation.

The fields on these motors are also supplied by rectifiers, which are fed from a 440-v ac substation. These rectifiers balance field currents under no-load conditions and armature current under load. A field regulator provides field weakening in three steps for reduced torque and high-speed rolling and eliminates drift during field weakening.

The motor-field regulators have load-limit control that prevents the motors from accelerating when the field weakens during excessive loads. Should slight overloads occur on long passes, the load control strengthens the fields to provide more torque. The load control maintains armature current at about 180% at top speed and 225% at base speed. Incorporated in the motor-field regulator is flux-rate-of-change feedback, which counteracts the eddy-current time constant of the machine and, in effect, permits the regulator to function as a flux-rate regulator instead of a field-current regulator.

Since a rectifier has no residual voltage, creep is not a problem. A complete stop or a suicide stop can be made when the master switch is in the off position without opening the breakers. Rectifier suppression is applied when the selector switch is in the off position for more than 5 sec.

The practically instantaneous response possible from a rectifier is used to advantage by providing a very fast current-limit regulator, which controls the rectifier voltage. If an overdraft is taken on the mill (i.e., the mill opening too small for the torque capabilities of the motors), the impact from the slab slows or stalls the motors without tripping the dc breakers.

Reflects Into Ac Lines

When a rectifier furnishes power for a reversing mill, power-system design problems are multiplied by the large kvar swings due to the impact loading of the mill. Unlike flywheel motor-generator sets, rectifiers reflect all power peaks into the ac system. How adversely this affects the ac system is dependent upon the stiffness or short-circuit capacity at the critical bus.

A reversing mill rectifier requires 100% phase control. Its power factor is very low except near rated

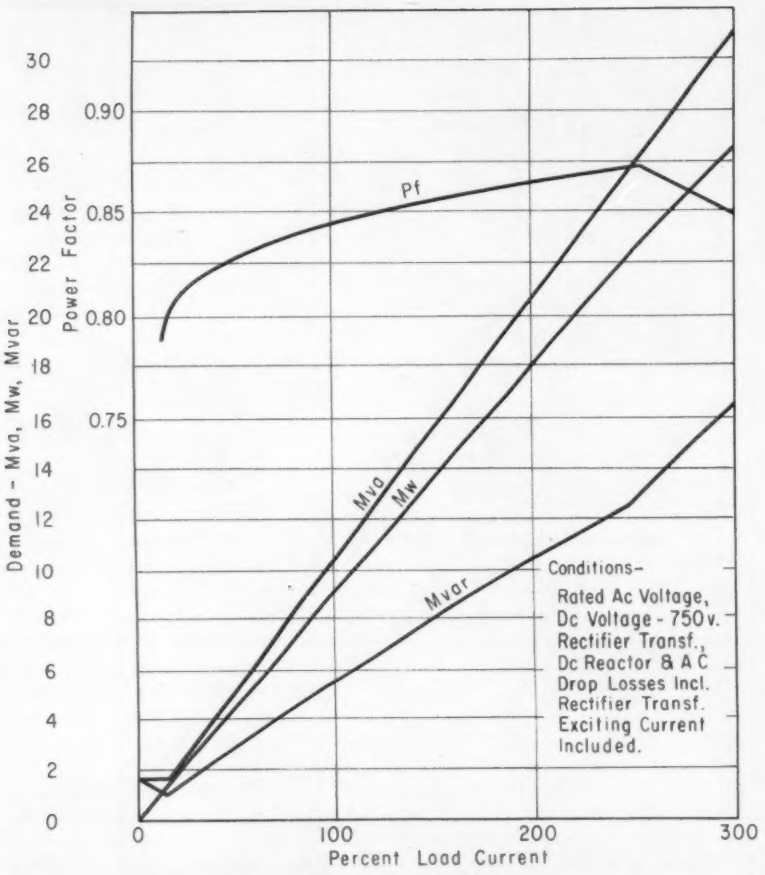


FIG 5—POWER CHARACTERISTICS of rectifier were determined by method shown opposite. Rectifier overload rating is 225% of rated motor current

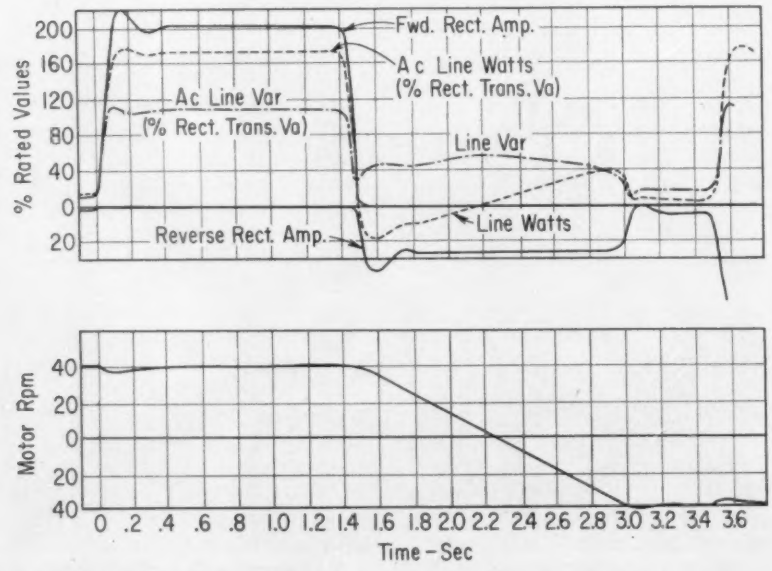


FIG 6—ONE REVERSING DRIVE PASS yields a profile like this, which, however, does not show volt-amperes as does that opposite

voltage. In order to keep the kvar peaks from becoming excessive, normal rolling practice at Lukens is to enter a piece into the mill at base speed or above (at rated voltage). Before this mill went into operation, corrective action was taken to make sure that the average plant power factor would stay within the limits specified by the utility in the power contract.

Since the utility was also interested in the amount of flicker caused by the fluctuating load, a load profile that permitted the utility engineers to calculate this flicker also had to be prepared. The first step was to determine the rectifier's power characteristics, shown in Fig 5 for the Lukens 8,000-kw rectifier. A method for deriving these curves is shown in the box opposite.

Load Profile Drawn

The rating of the drive for a mill is determined from typical schedules on which the mill is expected to roll. One schedule given by Lukens resulted in an rms load of 10,000 hp, which coincidentally is the motor rating selected for this mill. From the power characteristic curves of Fig 5 and the rolling schedule, a load profile curve was made. A portion of this profile is shown in Fig 7; similar profiles are customarily made for Mw and Mvar.

A typical operation for one pass shown in Fig 6 shows kw and kvar values determined from Fig 5 for a case when current goes to 225% during the time metal is in the mill. The fast current-limit regulator does not permit larger drafts without slowing or stalling the mill.

The current, power and reactive load during the reversal are always the same as during forward drive, and the kw and kvar are of like polarity on both the even and odd passes.

The value of kvar swing during a pass is minimized by circulating current between the rectifiers at no load. This current determines the change in kvar from no load to full load. The circulating current at no load in the Lukens rectifier is adjusted to about 15% of rated full-load current.

From the load profile, it is possible to determine roughly the frequency at which these load peaks

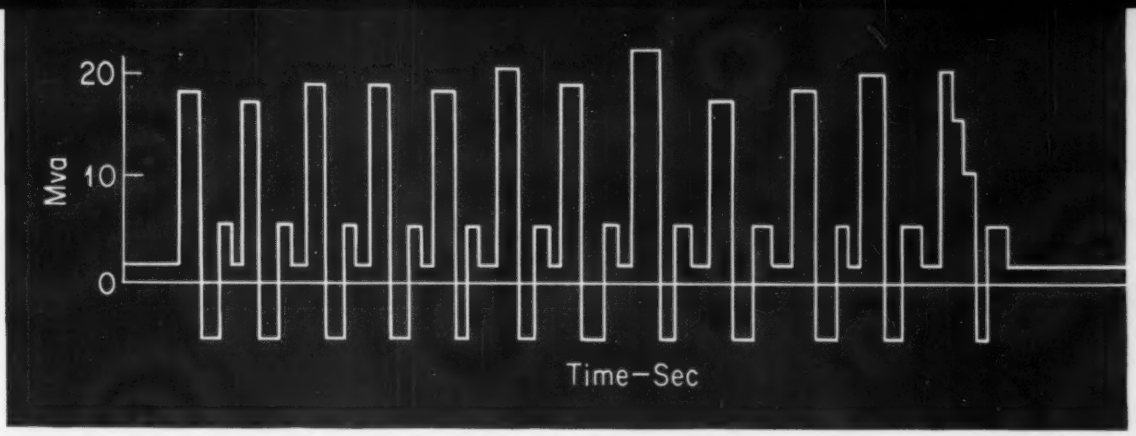


FIG 7—PARTIAL LOAD PROFILE for a typical rolling schedule is slightly aperiodic and irregular in wave shape. This one shows about 40 reversals per min of mill direction for rolling a slab. Blowup of one pass is shown opposite

occur and an average kvar swing when the slab hits the mill and when it leaves the mill. Fig 7 shows there are about ten passes in a 30-sec interval or 40 changes a minute. Load peaks of 200% are a typical change. As seen in Fig 5, this swing is 18,000 kw and 9,000 kvar.

When a slab hits the mill, it causes an impact load that reflects a very high rate of change of current on the power system. This rate of change is fast enough so that the transient reactance of a synchronous machine should be used in calculating the kvar drawn from the utility.

This kvar swing is determined from a short-circuit study by taking the ratio of short-circuit current neglecting all contributions except from the utility to short-circuit current including all other contributions. This ratio times the kvar swing of the rectifier is the kvar drawn from the utility. The Lukens power system draws 0.7 x 9,000 = 6,300 rectifier kvar from the utility for impact loads of 200%.

Flicker Negligible

Lukens Steel Co is supplied at 138 kv by the utility, which has a short-circuit capacity of approximately 0.0014 + j0.0092 per unit impedance on a 10-Mva base on its critical flicker bus at the substation feeding the Lukens load. A swing of 18,000-j6,300 kva causes a voltage drop of 1.01 v on a 120-v basis. On a flicker-limit chart, this voltage drop at a frequency of 40 reversals per minute plots at a point well below the threshold of objection for substations serving many customers.

Rectifier's power characteristics were calculated as a first step in determining the flicker it would cause on the electric utility's system. The steps here show how approximate power factor was calculated. (See Fig 5.)

E_{do} = theoretical no-load dc voltage
E_x = drop in dc voltage supplied due to ac system
= ½ (transformer reactance + ½ system reactance) · $E_{do}I$ for a 12-phase rectifier (in per unit of rectifier transformer rating)
V_t = dc rectifier terminal voltage, 750 v
E_a = dc arc drop
E_r = dc line resistance drop
I = dc load current (in per unit)

1. The specifications called for maintaining the ac power-system voltage at 0.95 per unit and a dc load of 1.75 per unit. From these, E_{do} was calculated by this equation:

$$E_{do} - E_x = V_t + E_r + E_a$$

2. With transformer reactance of 0.068 per unit on a 10,060-kva base and system short-circuit capacity of 225 Mva, E_x was calculated by the equation above:

$$\text{System reactance} = \frac{10{,}060}{225{,}000} = 0.0447 \text{ per unit on 10,060-kva base}$$

$$E_x = \tfrac{1}{2}\left(0.068 + \frac{0.0447}{2}\right) \cdot E_{do} \cdot 1.75$$
$$= 0.0703\, E_{do}$$

3. Good approximations for dc line resistance and arc drop were:

$$E_r = 0.02\, E_{do} I$$
$$E_a = 20 \text{ v}$$

4. Substituted in 1, above:

$$E_{do} - 0.0703 E_{do} = 750 + 0.02 E_{do} \cdot 1.75 + 20$$
$$E_{do} = 860 \text{ v}$$

5. E_{do} at 1.0 per unit ac volts:

$$E_{do} = \frac{860}{0.95} = 905 \text{ v}$$

6. Power factor:

$$pf = \frac{V_t + E_r + E_a}{E_{do}}$$
$$= \frac{750 + 20}{905} + 0.02I$$
$$= 0.850 + 0.02I$$

By substituting various per unit values of current into the above equation, an approximate power factor curve was made. (The curves of Fig. 5 account also for transformer excitation current, no-load circulating current and regulation after the rectifier has reached full advance. For the purposes outlined in this article, the above approximate method gives satisfactory results.) Once the power factor curve was obtained, the other curves were easily calculated from it.

Cement Plant Expansion Stresses

Two utility power sources, distribution centers near heavy loads are features

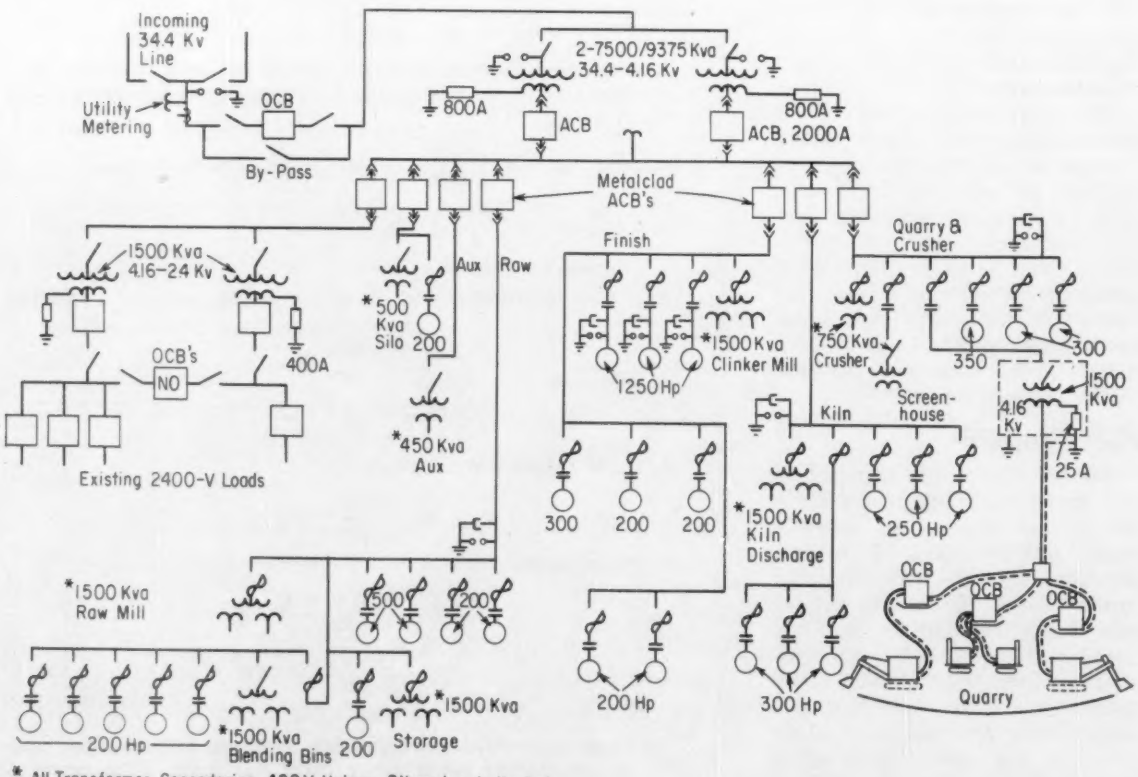
J. F. HOWER, Chief Electrical Engineer, Lehigh Portland Cement Co, Allentown, Pa.

A. C. LORDI, Industrial Engineer, Westinghouse Electric Corp, East Pittsburgh, Pa.

A distribution system design combining economy and low maintenance costs with high flexibility and personnel safety is a key feature in an expansion program that tripled both connected horsepower and output capacity in Lehigh Portland Cement Co's Union Bridge, Md. plant (shown on the cover). The system permits future expansion without disrupting normal plant operation. Serving as a model for several later plants, the Union Bridge facility was designed to include the latest electrical engineering practices, some of which were departures from traditional cement plant practice. For example:

- All power is now purchased and an existing 3,759-kva, 2.4-kv generating plant has been retired. This results from a change from short kilns, where waste heat could be used for generation, to longer kilns or preheating to utilize exhaust gas energy.
- All main power and control systems are distributed underground in a duct system. Sufficient spares are included to permit a further doubling of the plant's capacity.
- Distribution voltage was raised from 2.4 kv to 4.16 kv and power distributed through a series of power centers and grouped motor control centers located near the loads.
- All switchgear and control centers are located in clean, pressurized rooms to minimize maintenance in the inherently dusty atmosphere of a cement plant.
- In order to provide good on-the-spot process checks and reliable accounting records, departmental kwhr meters are installed on each metalclad switchgear unit and on each raw and clinker grinding mill.
- Distribution systems both in the plant and the quarry are resistance grounded to assure operating safety and to minimize equipment damage during ground faults.

Power is purchased from Potomac Edison Co at 34.5 kv. Two lines, either of which is normally used, feed the plant from separate sources. Line voltages



DOUBLE-ENDED SUBSTATION for 34.5-4.16 kv yields flexibility. Lines to quarry add safety ground wires

Flexibility

and phasing are controlled so the lines may be temporarily paralleled for transition from one line to another. Incoming-line short circuit capacity is 215 Mva symmetrical.

Instead of extending the existing 2.4-kv distribution system, 4.16-kv primary distribution was selected. Principle motives were the greater short circuit capacity of 5-kv breakers, reduced voltage drop and lower power losses. And 4.16 kv is an economical supply voltage for most of the large motors involved. Thus over one-half the 17,800 connected horsepower—thirteen 200-hp motors, three 250-hp, six 300-hp, one 350-hp, two 500-hp and three 1,250-hp motors—are served directly at the 4.16-kv distribution voltage.

Two 7,500/9,375-kva transformers step the incoming 34.5 kv down to 4.16 which serves the new expansion as well as the existing loads formerly fed by the 2.4-kv generator. Double-ended substations were used both for this transformation and for the 4.16 to 2.4-kv stepdown because of the greater flexibility and reliability. Single transformer operation permits periodic maintenance, no-load tap changing, and reduced capacity operation without an outage.

Bus Arrangements Vary

Paralleling the transformers permits a diversity of loading and a lower voltage regulation. Since the short circuit capacity of the 4-kv bus, including synchronous motor contribution, was only 135 Mva symmetrical and the breakers used have a 250-Mva rating, a single 4-kv bus was considered adequate.

By contrast, the 2.4-kv bus is split. Here, the existing 2.4-kv oil-immersed switchgear was rated 25 Mva, with a short circuit duty of 22 Mva on the 2.4-kv bus. To keep the short circuit capacity within this 25-Mva interrupting rating, the two 1,500-kva transformers supplying the existing 2.4-kv loads were chosen to have a 7.5% impedance and are operated with a normally open tie breaker.

The main substation is located on the windward side of the plant to minimize contamination. In addition, extra-creepage bushings and insulators were used to increase the creepage path to ground. A silicone compound is used on the substation porcelain to simplify periodic removal of encrusted contaminants.

The 4.16-kv and 2.4-kv distribution are resistance grounded to limit ground-fault current and thus fault damage to the large rotating apparatus. The resistance-grounded system also allows selective tripping on ground faults and avoids the transient overvoltages characteristic of large ungrounded systems. A resistor is used on each transformer to obviate resistor switches required when the neutral resistor is common to two transformers.

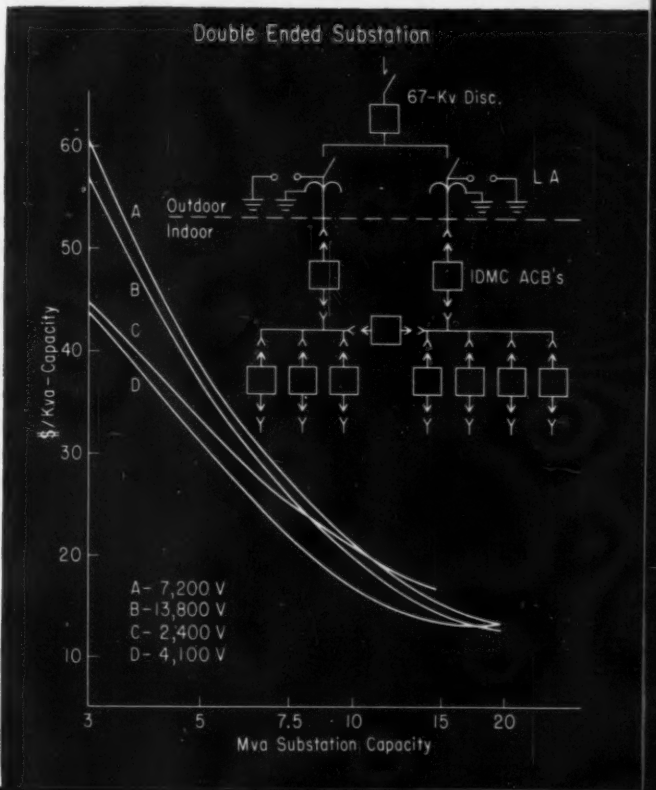
Protection for the substation apparatus on the 34.5-kv side of the substation is provided by an oil circuit breaker, which allows the use of fast sensitive relays and precludes single-phase operation. Also, primary circuit breakers can partially protect the distribution

PRESSURIZED SWITCHGEAR ROOM inhibits entrance of dust. Cleanliness keeps down maintenance bill

voltage side of the substation by relay action, operating to isolate ground faults between the transformers' secondaries and secondary breakers. These ground faults, when limited by the neutral grounding resistors, are not seen by primary fuses, and if not removed, may result in the destruction of faulted substation apparatus as well as the grounding resistors. A gang-operated bypass switch on the 34.5-kv breaker allows periodic breaker maintenance without a power outage.

Voltage drop was calculated for the most severe system requirement: starting the 4-kv, 1,250-hp motors. Based on the normal power system characteristics, the drop during starting was estimated to be 8%, within the desired 15% maximum drop. The possibility of

COMPARISON OF VOLTAGES for low side of main transformers favors 4.16 kv, the potential finally selected



equipment malfunctioning becomes real when a 15% drop is exceeded.

Two 2,000-amp incoming line main and seven 1,200-amp feeder air breakers control and protect the 4.16-kv cable feeders. These breakers are located in a clean, pressurized switchgear room to minimize the dust problem (see photo). The radial distribution system was used as it offers the advantages of low cost and simplicity.

The feeder breakers' short circuit and momentary requirements are those of the substation, 135 Mva symmetrical and 290 Mva asymmetrical (including motor contribution). The breakers chosen were 5-kv drawout metalclad units with 250-Mva interrupting capacity and 60,000-amp momentary capacity, providing a margin for power system expansion.

More Breakers Planned For

To allow independent departmental operation, a feeder circuit breaker is used for each plant department. The breaker bus is center fed to allow addition of feeder breakers on the ends of the switchgear lineup.

Each main incoming-line breaker cubicle contains a voltmeter, ammeter, power-factor meter and switch, and differential relays, in addition to the conventional phase and ground overcurrent relays. Each feeder circuit contains an ammeter, a power-factor meter switch with removable key (power-factor meter on main breaker cubicle also reads feeder pf), a kwhr meter, a recording wattmeter, and induction-disc phase and ground overcurrent relays. An auxiliary cubicle contains potential transformers and the control for the 34.5-kv outdoor oil breaker.

All main power and control cables are distributed underground in a duct system. The conduits are rigid steel, hot-dip galvanized. All conduits were sized one size larger than needed to prevent cable damage during pulling and make pulling easier. Sufficient spares are included in the original installation to double the plant's capacity. The entire duct system is completely encased in concrete and reinforced where needed for traffic conditions. Underground power and control circuits use separate ducts into common manholes; communication systems have separate independent ducts and manholes.

The feeder cables from the outdoor sub to the switchgear room and from the switchgear room to the various departments are all single-conductor, shielded, 5-kv butyl-insulated, and neoprene-jacketed. The largest cable size considered practical for pulling into conduits was 500 MCM. Multiple cables are used where additional capacity is required. To prevent cable damage in event of a 3-phase fault on the 4.16-kv system, the minimum size used was No. 4/0.

To assist plant personnel in maintenance work, all conduits in the manholes were numbered with metal tags. All wires and cables were numbered with terminal and circuit numbers using pressure-sensitive tapes.

Lower voltage drop, less power loss and more flexibility, as well as lower initial investment and increased reliability were realized by the use of the smaller power centers located near load concentrations. All power centers except the silos are sized to be about 85% of the connected horsepower and transformer kva. For silos, a value between 35% and 40% of connected kva is normally used.

Control centers are located very near power centers so the required control centers' fault capacities are essentially those of the power centers. To eliminate vaults required for oil-cooled transformers or heavier maintenance required for ventilated dry type, all indoor transformers are askarel-cooled units. One additional advantage of the askarel units is that operators can check operating temperature by placing their hands on the units.

Kiln Supply Backed Up

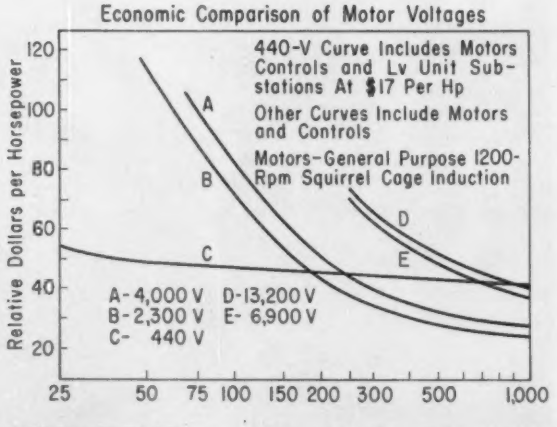
The eight indoor askarel power-center transformers at the Union Bridge plant are rated 1,500 kva or smaller. Transformers larger than 500 kva include provisions for future forced air cooling. Five of the 480-v transformers are rated 1,500 kva. These are wound with dual 750-kva secondaries, which are operated separately to keep short circuit capacity within the standard control-center requirements. The low-voltage transformers are close-coupled to control centers. Secondary selective, 480-v, normally open tie breakers are included in the kiln, blending and storage power center to increase the source reliability of these critical loads. Interlocking prevents paralleled operation of power centers.

Each power center includes potential transformers and ground detector voltmeters to indicate the first ground on the system, normally operated ungrounded. An immediate power outage is scheduled to remove the ground from the system. Thus, it is believed an additional degree of service continuity is obtained under proper maintenance and operating conditions by turning an unplanned outage into a planned one.

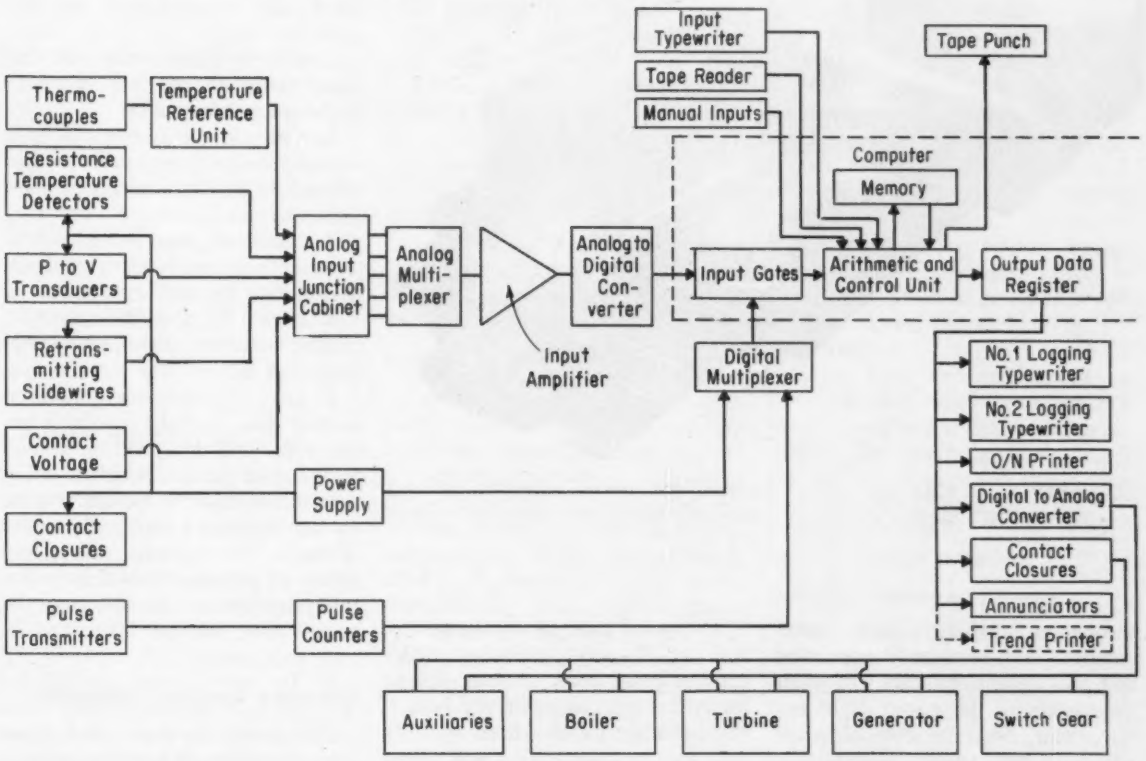
In the cement plant quarry, the widely varying ground impedance and the use of portable equipment require special safety grounding precautions for personnel safety.

A 500-kva, 4.16-kv delta primary, 4.16-kv wye secondary transformer isolates the plant distribution system from the quarry system, thus permits the use of the safety neutral grounded system, which keeps por-

(*Continued on page* 84)



MOTOR VOLTAGE comparison was another of the economy studies carried out for the Union Bridge cement plant



Automated Plant Has One Operator

Riverside Station's boiler-turbine-generator units to go under digital computer control for peaking operation

L. R. EDDINS, Superintendent, Riverside Station, Lake Charles, La.,
J. L. WARMACK, Electrical Engineer, System, Gulf States Utilities Co, Beaumont, Texas.

Rapid expansion with high-efficiency generating units of the reheat type and the availability of equipment for automatic operation of boiler-turbine-generator units prompted Gulf States Utilities Co to automate two units for peaking operation at its Riverside Station at Lake Charles, La.

Automatic peaking operation was preferred to relegating this equipment to stand-by duty, as the company's experience with stand-by stations had been unsatisfactory and expensive. Hence the Riverside installation will be the first for automatic operation of installed boiler-turbine-generator equipment.

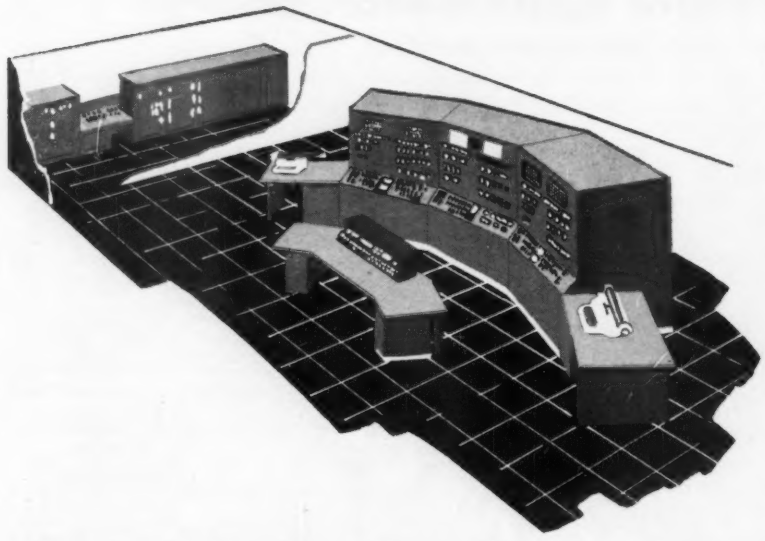
Riverside is ideal for peaking operation, and some data-handling equipment, installed there in 1957, brought a reduction of the operating force by 32%. Plans now call for Riverside's conversion to automatic operation on a peaking schedule with only one operator per shift and the release of 13 trained operators for duty elsewhere.

The Riverside project has been approached with the objective of controlling the plant by means of a digital computer, once changes in equipment have compensated for operating limitations. Under computer control, the plant's individual units will start and stop as required, only one unit starting at a time. To simplify operating practices and to aid in computer programing, both units will be as much alike as is economically feasible.

The RCA 110 industrial control computer to be used in the systemation of the two boilers and two turbogenerator units is a combined system using a magnetic core memory and a magnetic drum memory. This unique marriage of computer memory systems is expected to meet the requirements of high-speed operation and bulk storage of data.

The control computer system will contain a 4,096-word random-access, coincident-current magnetic core memory with each computer word containing 23 bits plus sign and a 16,384-word magnetic drum memory of the same word size. It is anticipated that the sizing of the memory units is enough for startup, shutdown and normal running control of the two units.

Circuitry will be solid-state



COMPUTER CONTROLS will convert Riverside Station to automatic peaking operation and will replace the central information system now installed in plant

throughout. Heavy duty metal cabinets and prudent construction and packaging techniques will adapt the system to the power plant environment, and the control room will have its own air conditioning. As a safeguard against operation in emergency high ambient temperatures, which could limit the operating efficiency of the system, heat exchangers will be built into all cabinets.

Pick High-Speed Memory

The random-access magnetic core memory was selected because it operates faster than the magnetic drum. An average speed increase of at least 4:1 can be realized with the core memory, even though a serious attempt is made to optimize the program arrangement on the drum to minimize access time. Use of two memory units facilitates simultaneous input and output of information.

The automatic priority interruption feature of the computer will force program functions of major importance or urgency to interrupt less critical programing functions. Several programs can be in progress at any time, but the program with the higher priority will take precedence. This will allow lengthy computations to progress in various stages under adequate control and supervision at all times.

The word time of the computer will be 28 μsec, including high-speed-access time. Access times for operational purposes will be 8.3 msec average for the drum and 3.5 μsec for the cores. This will allow operation times of 56 μsec for addition and subtraction, 728 for multiplication, and 868 for division. A maximum operation rate of 17,850 instructions per sec can be obtained.

The programer will have available a powerful complement of 71 commands and seven index registers for address modification. With these tools, a complete stored program for the system can be written quickly and efficiently.

Program Entry Is by Tape

Normally program entry will be made from punched paper tape through a high-speed photoelectric reader. A programer's console will be used for program modification. Raw data will enter the system through an input scanner utilizing mercury-wetted relays. These will be the only relay devices performing a major function in the system. All types of input data, such as current, voltage, pulse, contact closure, and pressure, will be accepted. Transducing devices will be used where necessary. A differential amplifier with linearity of $\pm$ 0.05% will minimize common mode pickup. The analog-to-digital conversion accuracy will be $\pm$ 0.1%.

Digital-to-analog converters will provide the control output signals which will be displayed in four ways:

1. A strip printer will give fast digital display of "off normal" single-point information

2. Two electric typewriters, one for each boiler-turbogenerator unit, will record unit data hourly or upon demand

3. Selectable trend recorders will provide fast, continuously updated analog data for any input point

4. Digital lights on the operator's console will give single-point visual display of data.

Departure from and return to normal data, including point number, value and time, will be printed by the strip printer, which together with the operator's console will be on the operator's desk. By either of these, the operator will obtain values of any operating data in the computer system by selecting the proper point number on rotary decade switches.

Operating Routines Automatic

The entire start-up and shutdown routines will be in stored program form on the drum. The computer system will, upon command, place the boiler in service in proper safe sequence; bring the turbine through the start-up procedures; and, synchronize the generator and connect it to the transmission system without an operator's intervention.

Control of the boiler-turbogenerator will remain under computer supervision until the unit load has increased above the minimum control points for each individual sub-loop control. Transfer will be made to the individual sub-loop controls and unit loading will be supervised by the system load dispatcher.

Upon reduction of load and shutdown of the unit, the computer will re-establish control when the minimum control point is reached. At any time during the startup, shutdown, or normal operation, the operator can assume control. Throughout the control programs and during sub-loop control operation, the computer continuously scan-monitors all data for proper operation within predetermined safe limits. Detection of abnormal conditions will signal an alarm,

print out the point number, time and value and, if necessary, initiate an orderly unit shutdown.

Before a unit can be placed in service, there are operations that must be performed by someone other than the operator in the control room. This person must see that the boiler is filled with water to the proper firing level and that manually operated electrical disconnects are closed. There are also several duties that the "day-man" must perform to put the unit in operation.

These preliminaries will be checked off with a manual check list, and the unit will be ready to go into operation.

Automatic Starting Sequence

The operator's push button will initiate the opening of the boiler drum vents and header drains, charge the gas header system, purge the furnace, and indicate to the operator and the computer that the boiler is ready for push-button lightoff of the first burner.

Following completion of the boiler furnace purge, lighting the first burner will present a problem of controlling the burner gas-header pressure. This will be accomplished by adding a low gas pressure regulator in parallel with the combustion control valve. This pressure regulator will be set for about 2 lb downstream pressure control. The manual gas header vent valve will be replaced by a diaphragm-operated valve which will purge air from the gas line when charging the burner gas header with fuel and will relieve gas-header pressure above 2½ lb. This will take care of leakage of the low-pressure regulator, or improper setting of the combustion-control valve. This system will also minimize the gas vented to atmosphere during initial lightoff. The vent valve will be closed except for initial lightoff, or when the boiler is out of service. The proper burner air register positions for initial lightoff will be preset by test and held in position by the sequence control.

The remote burner control system will permit:

1. Automatic lightoff of any burner from the control room

2. Shutdown of any burner from the control room, principally for load requirements

3. Opening of all burner registers only as permissive condition to purging the furnace

4. Shutting of all burner cocks when the main boiler fuel trip valve goes closed

5. Local operation at the boiler front of each burner for maintenance and the conduct of performance checks.

The remote burner control system will operate the burner safely and supervise the burner flame. Should a burner go out, the fuel cock and air register on that burner will close in about 4 sec.

Lightoff Is Automatic Too

Besides flame sensing, the remote burner control system will provide automatic, sequenced safe lightoff of individual burners. Component checkers on the flame-sensing relays will check the operation of the flame-sensing device several times per hr. A component failure of the flame-sensing relay, indicated on the boiler control board, will tell the operator that maintenance or adjustment of that particular flame-sensing device is required.

Boiler drum vents and header drains, which must be closed or adjusted after putting a fire in the boiler, will be computer controlled to let the operator stay at his control board.

Serious consideration was given to installing furnace television. As the furnaces were not designed to incorporate television cameras, physical handicaps were anticipated. Also, there are definite differences of opinion concerning furnace television. Some companies install television; others would not. The burner controls subcontractor reports more than 30 installations without television. The decision to dispense with furnace television followed investigation of the problems.

No great trouble is anticipated in controlling the boiler feed pumps or feed-water regulating valves. New thermocouples will be installed, and the boiler feed pump discharge valves will be motorized. Interlocks will assure open suction valves.

Unit 2, which includes the turbogenerator, boiler, and all auxiliaries, will go on automatic controls first, although work will proceed without delay on Unit 1.

A wide-range governor will be installed on Unit 2. This essential for automatic control will permit control of the turbine speed setting from turning gear to rated speed with a minimum of computer memory. The wide-range governor will be used also as a remote-load limit control to close the inlet valves while the throttle valve is being opened. The turbine will be brought to speed by having the throttle valve open and controlling the turbine from the inlet valves. When the installation of automation equipment with the necessary devices is completed, it will be possible to roll and accelerate the turbine by remote control.

Supervisory instruments will be on the turbine. Shell expansion will be measured and logged by the computer. The shell-expansion detector will be a standard linear motion transducer mounted on No. 1 pedestal with baffle plates to protect it from cylinder heat.

Detectors Measure Vibration

Vibration will be measured by shaft-riding detectors on each main bearing. One detector, probably that on No. 2 bearing, will be logged continuously. If, for any reason, the vibration on some bearing other than the one being scanned should increase to a point above the one being scanned, the instrument will start to show the higher vibration reading. The detector signals will be selected by the computer and switched to a standard power unit. Output of the power unit will be scanned for off-normal alarms, and trend will be recorded or logged as required.

A shaft-eccentricity detecting system will show the straightness of the high-pressure spindle at turning gear speed. The measurement of shaft eccentricity will be a good indication of readiness to accelerate to rated speed. A standard detector coil or coils will be mounted in the No. 1 pedestal.

The main journal bearings, the thrust bearing shoes, the hydrogen-seal shoes, and the corresponding pedestals will be drilled for new thermocouples, which will also be installed in the cylinder metal, near both the inner and outer surfaces and at the flange. Then these signals will be a guide in establishing maximum rates of load change.

Diaphragm-operated water valves

(*Continued on page* 84)

NUMBERED PLASTIC TAPE is precisely positioned on cable to achieve reference points for creep measurements

Eye-Piece Monitors Pipe-Cable Movement

F. B. SCHULLERTS, Senior Electrical Engineer, Pacific Gas & Electric Co, San Francisco, Calif.

A job-fabricated eye-piece recently permitted precise monitoring of the movement of a Pacific Gas & Electric Co pipe-type cable due to downhill creep during load cycling. Furthermore, the constant monitoring of the cable-pipe proved that the normal bends incurred in following the geographical route down a steep, 20% grade, San Francisco hill have proven sufficient to limit movement of a 115-kv gas-filled pipe-type cable.

When the underground cable was being installed, the question arose as to whether some means should be provided to anchor the cables. Excessive cable movement and cumulative downhill creep during load cycling might cause cable or terminal damage. Four methods were considered:

- Gripping each cable by means of basket, or by so-called strip grips, either at manholes or at random intermediary points or both.
- Using extra large conductor cables in the critical area so as to reduce thermal expansion.
- Deliberately introducing additional horizontal bends in the critical creep area to act as an expansion bend and provide a snubbing action.
- Relying on bends normally required to follow the route in the horizontal plane and proposed profile.

The first alternative was eliminated because of the possibility of insulation damage. The last was selected as the most economical and satisfactory since it was considered likely that some of the thermal expansion would be taken up in "bird-caging" of the cables in the pipe.

However, to verify that the method selected was satisfactory, a window was placed in the pipe at the high point in the cable profile. In actual design, a portable eye-piece was constructed that could be attached to a permanent gate valve which was welded to a splice casing in a manhole. Gasketed ¾-in. thick plexiglass provided the means of viewing the cable when the valve was in the open position. To facilitate measurement of cable movement, thin lines were scratched on the plexiglass and twelve pieces of tape were wrapped around the cable at one-inch intervals—six on each side of a selected reference point. A mirror was secured to the eye-piece at 45-deg in order to view the cable with safety and a pen-size flashlight held vertically and to one side provided sufficient illumination.

The maximum movement noted by PG&E during two years of commercial operation has been about ⅜-in.; and, the maximum movement was about 1-in. during a heat run test on the completed circuit, during which the cable was subjected to two full load cycles. These figures are considered normal and not excessive.

Incidentally, such a portable eye-piece might also be of use in locating the cause of a fault. Each splice casing interior could be inspected through such an eye-piece to detect a splice failure, providing considerable insulation burning had occurred.

CREEP OF CABLE is determined by sighting through eye-piece the numbered tape at the centered scratch line

Encapsulated Transformer Is Field-Tested

W. A. McMORRIS, Distribution Transformer Department, General Electric Co, Pittsfield, Mass.

The first encapsulated distribution transformer for 2,400 to 7,620-v service is now undergoing field tests to prove out its design and materials and determine its applications. Its development is a consequence of investigations of new insulating resins for reducing the size, weight, inflammability, and costs of electrical equipment.

The encapsulated transformer has only natural cooling, having disposed of the tank and insulating oil which are the prime means of heat dissipation in the conventional transformer. Accordingly, this smaller and lighter distribution transformer presupposes a solution of this thermal problem.

This problem was licked by the development of an encapsulating resin with good thermal conductivity and the ability to tolerate temperatures well above Class A limits. Paper and similar materials unsuitable for high-temperature operation were eliminated, and the proportions of the coil structure were modified to minimize internal temperature drops and maximize heat transfer to the air.

These measures took a dilemma by the horns. For, although increased core iron and winding copper ordinarily reduce the heat to be dissipated, such increases were limited in the encapsulated transformer by the over-all objective of small size and light weight.

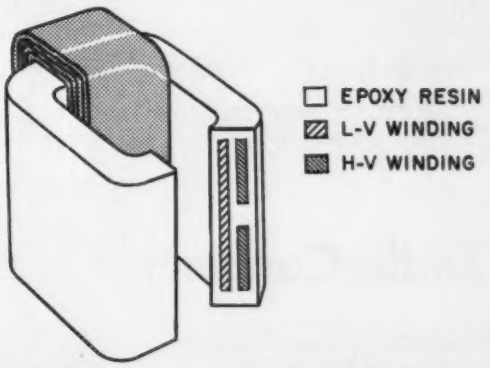
Other Handicaps Overcome

Another handicap to the development of the encapsulated transformer was the low dielectric strength of some early encapsulated windings. This was found to be due, in part, to incomplete penetration of the resin into the winding. Voids, particularly those in high-voltage-stress areas, caused radio noise and low dielectric strength.

These voids were eliminated when a more open winding structure was substituted, along with a more carefully selected resin and filling process. In this way, both the dielectric strength and the radio noise characteristics were improved. Yet performance remained below that of the oil-filled unit; samples, initially acceptable, developed radio noise after exposure to extreme temperature cycles.

But performance equivalent to that of the conventional transformer was at length achieved merely by vacuum-impregnating the high-voltage windings with a small amount of mineral oil. Only about a pint was used in the 15 and 25-kva ratings. This oil holds up better at high temperatures in the encapsulated windings than does the conventional oil in paper-insulated windings.

Other problems solved in the development of this transformer involved the methods for vacuum-casting the resin, oil impregnating, and sealing. Many units were built and tested for loading, dielectric strength, short-circuit strength, radio noise, audible sound, and thermal cycling. These laboratory tests indicated that the transformers would perform satisfactorily.



ENCAPSULATED DISTRIBUTION TRANSFORMER is the culmination of many years of research to find a resin insulation and unit design that would replace conventional unit, bulky and weighty with tank and insulating oil

But some design concepts and materials have not been proved in service, and the results of the present field tests are expected to afford guidance in future design trends.

In the early steps in the transformer's development, in 1950, a more or less conventional coil construction with paper winding forms and layer insulation had been used. Additional wraps of paper were placed over the outside of the windings to increase the insulation at this point so that it would withstand the primary voltage. The entire winding assembly was impregnated with a clear polyester resin which was then cured by baking.

Two Major Deficiencies Appear

But two major deficiencies appeared in this design under test. The winding temperature rises under load were much higher than in oil-filled designs of like proportions and were beyond the capabilities of the materials used. The dielectric strength, as revealed by impulse and other dielectric tests, was only a fraction of that of conventional distribution transformers.

More recent work revolved around the correction of these deficiencies and culminated in the announcement by the manufacturer that an encapsulated distribution transformer had been developed and was being given field trials.

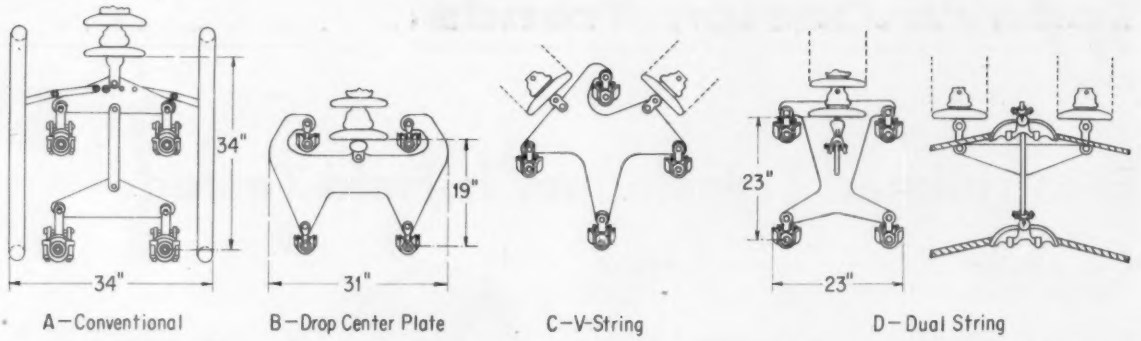


FIG 1—PROTOTYPE HARDWARE for multi-conductor systems is compared with conventional assembly. The three configurations—drop center plate, vee-string, and dual string—are for four-conductor supports on pole lines

Bundle-Conductor Hardware Cuts R/W Costs

R. W. HARMON, Development Engineer, Ohio Brass Co, Barberton, Ohio*

Prototype hardware, supporting multiple-conductor systems and in configurations for compact coupling of insulators and conductors, proved successful in laboratory tests. Insulators and hardware were corona-free up to and beyond 650 kv, even without control shields.

Operation with RI voltages less than those on 345-kv suspension assemblies depends upon close coupling of the insulators and conductors, permitting the bundle system to perform the insulator shielding functions of control rings; and, design of corona-free clamps and hardware to operate without control rings. The photo shows insulators and hardware corona-free at 350 kv to ground with 6.000 μv of RI voltage on polished 0.80-in.-dia ACSR conductors.

When, as in Fig 2, insulator swing angles of 45 deg and striking distances of 10 ft are assumed, there are these advantages:

1. Phase spacing is cut 3 ft, increasing transmission capability and improving transient stability.

2. Phase and ground wires more closely coupled improve lightning performance.

3. Structure dimensions are shortened, and forces within the structure are reduced, so that lighter members can be used.

4. Right-of-way width requirements are 6 to 9 ft less, the reduction equaling twice the phase spacing based on the normal conductor position and three times the phase spacing based on the conductors' maximum blow-out position.

The conductors' elevation is limited by yoke plate mechanical stability, and severe icing could reduce clamp-to-insulator clearance.

* Based on AIEE Transactions Paper 61-171, "Effect of Bundle Conductor Field Influence on EHV Transmission Line Design."

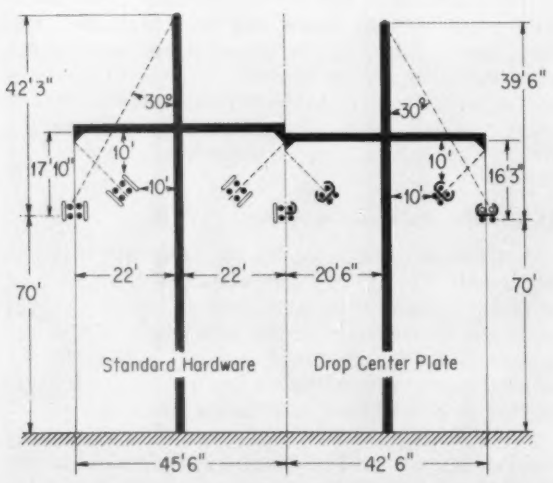
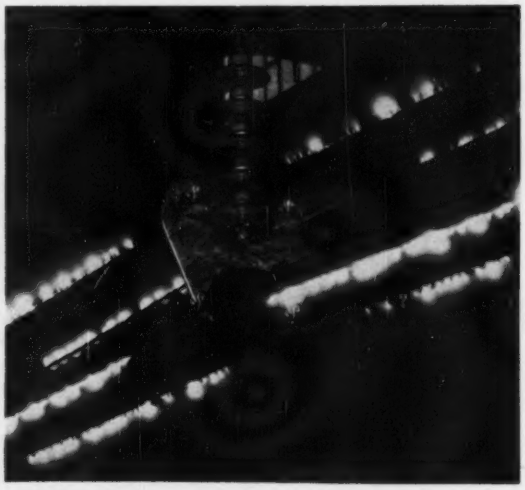


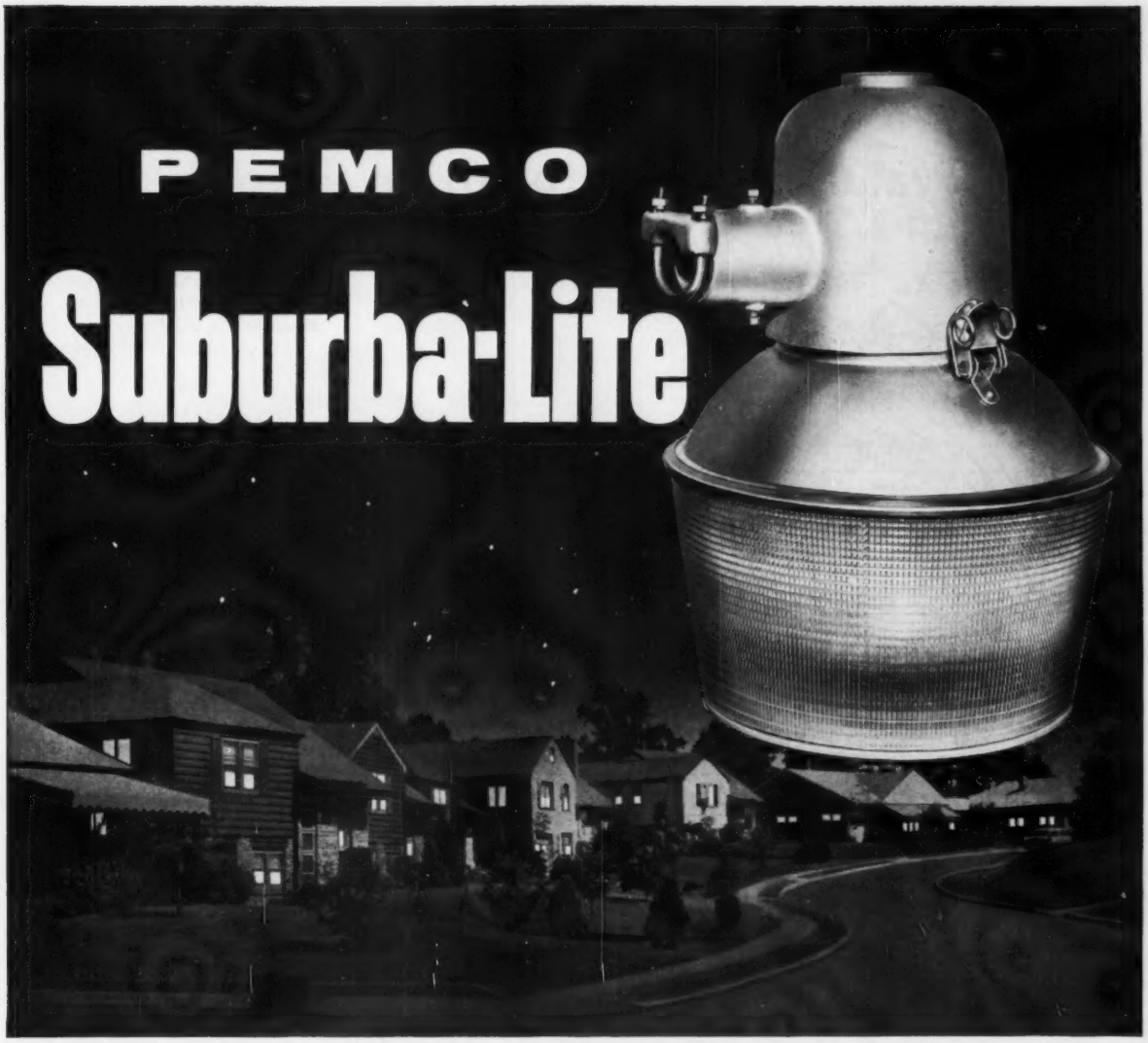
FIG 2—EFFECTS of close-coupled assemblies on tower and right-of-way dimensions are shown in above comparison

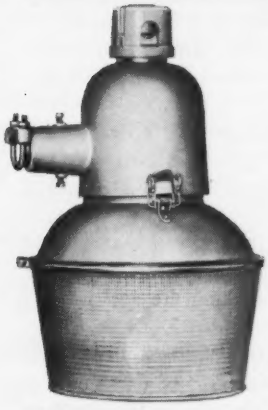


CORONA PHOTO shows insulators and hardware corona-free in laboratory tests at 350 kv

PEMCO

Suburba-Lite





The new PEMCO SUBURBA-LITE is designed for residential streets, parkways, recreation areas, parking areas, home, farm, commercial and industrial protective lighting.

With side entrance or top entrance EEI-NEMA standard head.
For incandescent lamps or with internal ballast for mercury lamps.
With Pemco-Holophane Open Bottom Refractor for easy relamping and reduced cleaning cost.
IES Type II, Type II-4 way and Type V.
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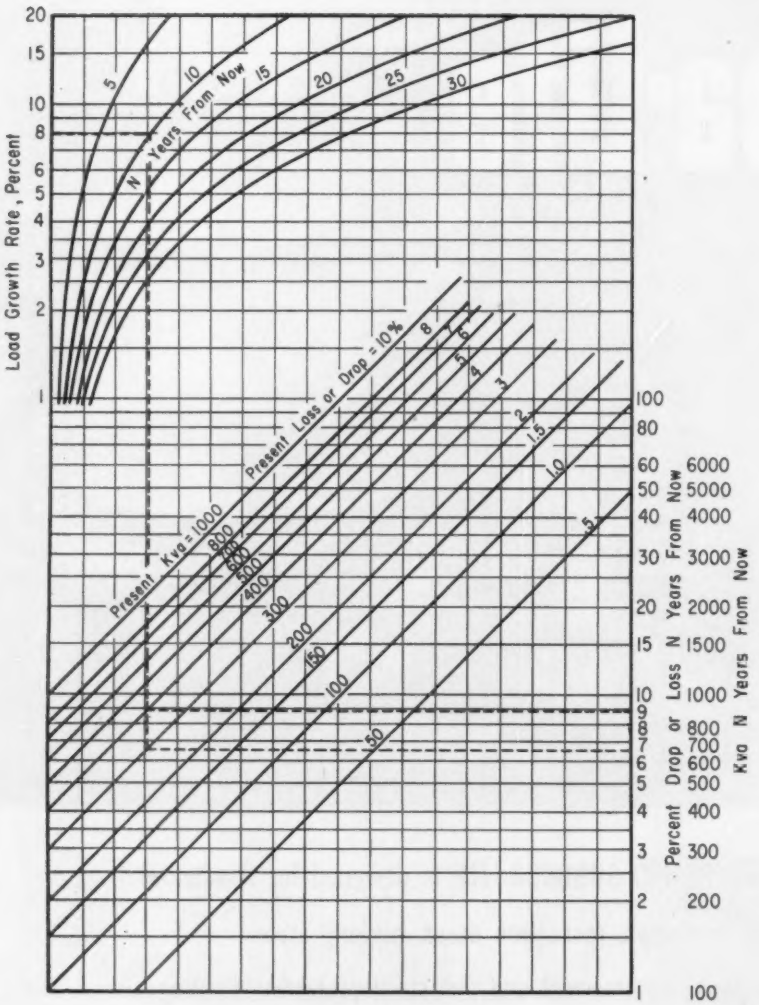
PEMCO LIGHTING HAS BEEN QUALITY LIGHTING SINCE 1882

Evaluate Load Growth on Feeder

R. A. DEWBERRY, Electrical Engineer, Montana-Dakota Utilities Co, Minneapolis, Minn.



Future peak load and voltage drop on a distribution feeder resulting from uniform load growth may be evaluated with a chart devised by the author. The chart is based on the fact that an electric distribution feeder with a constant growth rate **i** and an initial load of kva_o will, at the end of **n** years, attain a load of kva_n, given by equation **(1).**

Likewise, because the percent voltage drop and percent power loss are directly proportional to the kva, the percent drop or loss after **n** years will also hold the relationship as given in equations (2) and (3). The chart readily evaluates these three equations.

For example, a feeder with a constant growth rate of 8% has a peak load of 400 kva and a drop of 3%. What will the peak load be in ten years and what will the voltage drop be if the same conductors are still in use?

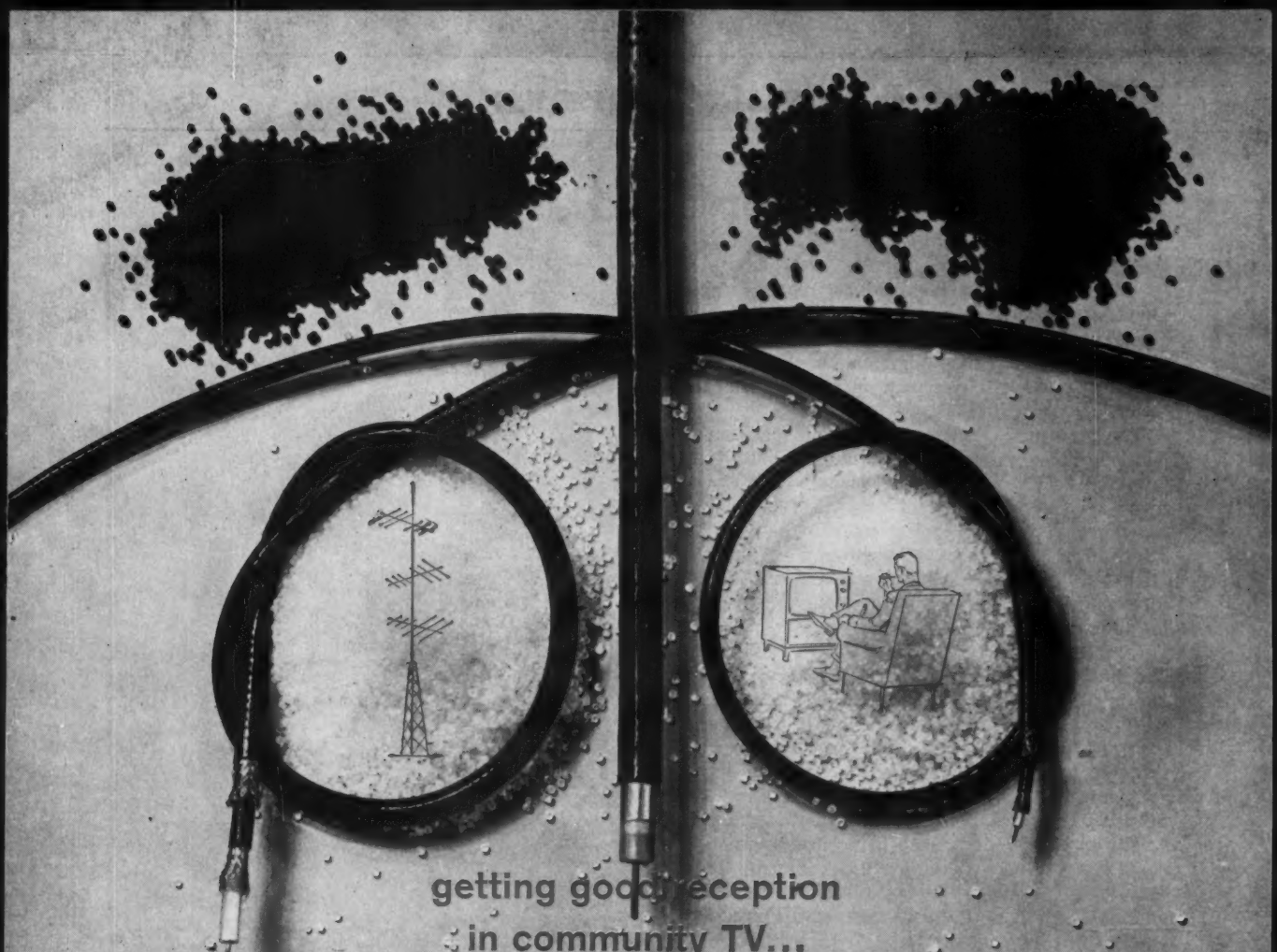
Enter the chart at upper left at a growth rate of 8% and extend horizontally to the ten-year curve. From here drop vertically to the 400-kva line and to the 3% voltage-drop line. From these points project horizontally to the right and read $kva_n = 880$ and percent $drop_n = 6.5\%$.

Equations Evaluate Voltage Drop and Power Loss

(1) $Kva_n = Kva_o\ (1 + i)^n$
where i is the percent load growth rate expressed as a decimal.

(2) Percent $drop_n$ = Percent $drop_o\ (1 + i)^n$

(3) Percent $loss_n$ = Percent $loss_o\ (1 + i)^n$



getting good reception
in community TV...

Mohawk's H-F coaxials, jacketed and insulated with TENITE POLYETHYLENE

For community television distributing systems in any area, Mohawk H-F coaxials do a complete transmission job, from tower or relay station right into the living room.

Tenite Polyethylene is used as jacketing and insulating material on these cables. It offers all-round high performance which gives them long life, keeps line loss low, and permits ease in installation.

As a jacketing material, tough Tenite Polyethylene provides excellent resistance to abrasion, weathering, moisture, and heat. Users can look forward to years of maximum protection.

As an insulating material, Tenite Polyethylene has a low power factor, which holds energy losses to a minimum. In these Mohawk cables, both solid and foamed Tenite Polyethylene are used for primary insulation... the foamed material having an even lower dielectric constant than the solid, thus making possible a thinner insulation with a resulting decrease in cable weight.

Linemen find that cable jacketed with lightweight Tenite Polyethylene is easy to handle and strip and is flexible even at sub-zero temperatures.

There is a formulation of Tenite Polyethylene to meet the demands of most insulating and jacketing applications. For further information on this useful plastic, write EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

● *Both natural and black electrical grade Tenite Polyethylene are available to cable manufacturers as unique spherical pellets which flow freely in the extrusion process and in "air-veying" bulk shipments from truck to bin.*

● *Cable manufactured by Mohawk Wire & Cable Corporation, 320 River Street, Fitchburg, Massachusetts. Jacketing and insulation extruded of Tenite Polyethylene.*

TENITE®
POLYETHYLENE
an Eastman plastic

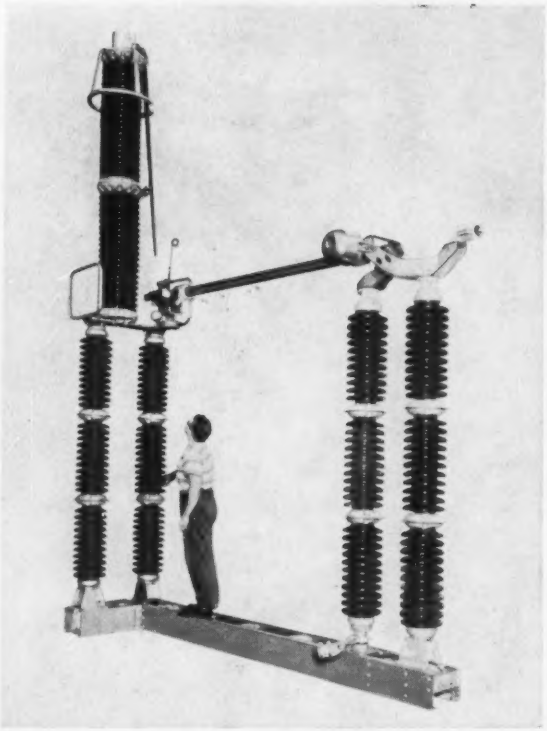
Vacuum Interrupter Used as Circuit Breaker

A 230-kv vacuum-type interrupter switch to serve in place of a circuit breaker was recently built by Delta-Star Electric Div, H. K. Porter Co, Inc, in Chicago. Especially designed to interrupt a 230-kv transmission line, it is a combination of vertical-break disconnect and eight vacuum interrupters stacked in series, one above the other.

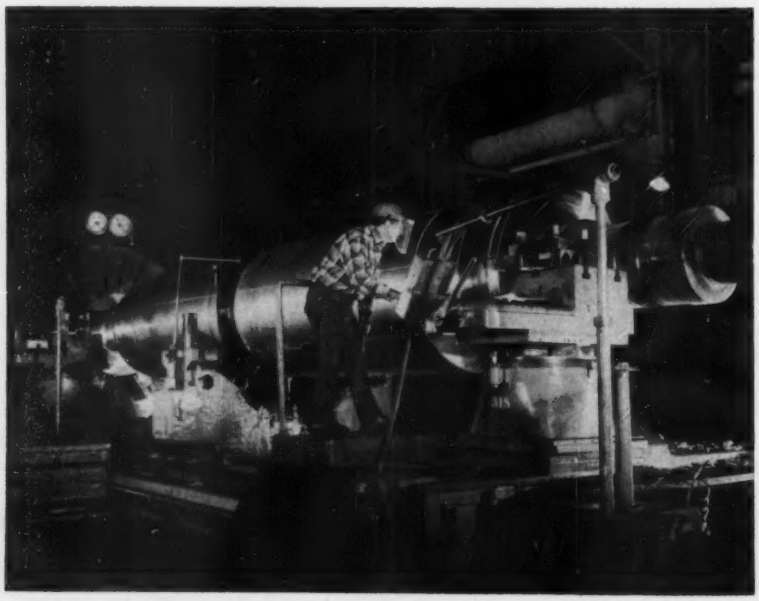
The glass-enveloped interrupters are enclosed in a 9-ft porcelain tube which is mounted adjacent to the jaw contact. Each individual vacuum switch can be given a voltage test without removing the stack from the porcelain. The complete interrupting unit stands 18 ft high. The unusual height and weight require an extra supporting insulator stack at the front end for stability. Thus, the disconnect has four supporting insulator stacks instead of three.

Operation of this special MKV-40 switch is simple and automatic. On opening, the disconnect blade rises and picks up an aluminum arm extending into its travel path from a mechanism on top of the interrupter tube. As the blade touches the arm, current is shunted through the vacuum interrupters. When the arm reaches a predetermined position, the interrupters are opened. The blade then drops the arm, which is instantly spring-driven back to its normal position.

The new switch is designed to interrupt circuits previously interrupted by an oil circuit breaker—at approximately one-fourth the cost, says Porter Co.



US Steel Produces 115-Ton Rotor



A massive generator rotor was recently forged and machined at United States Steel's Homestead District Works. Shown during machining on a 120-in. lathe in the plant's forge division, the rotor weighed in at 228,870 lb—making it one of the largest ever produced. It is 38 ft, 9 in. long with a diameter of 59½ in. for 20 ft of its length.

Produced for the General Electric Co, the giant rotor was forged and machined from a 110-in.-dia ingot of nickel-molybdenum-vanadium steel. This ingot was vacuum cast in the electric furnace department at the corporation's Duquesne Works to insure the best possible quality throughout the finished rotor. When installed in the completed generator, the rotor will spin at 3,600 rpm.

(*More News of Manufacturers, p* 60)

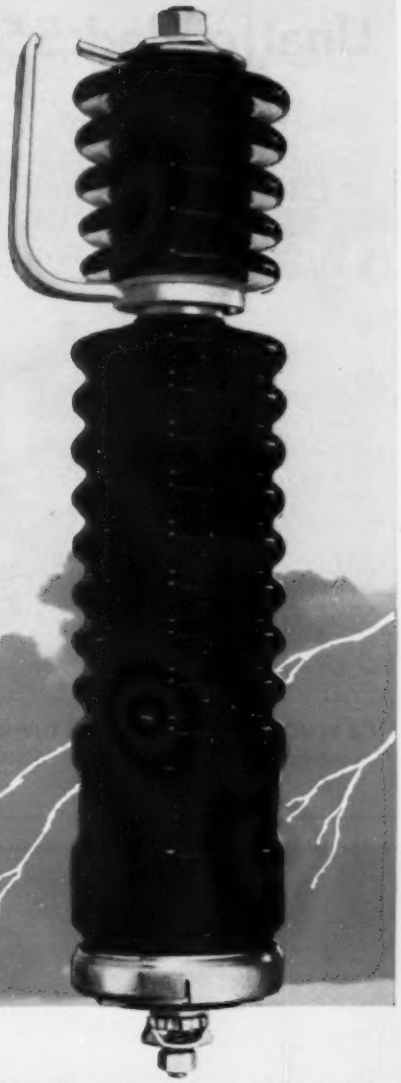
Only the new

KEARNEY

UNIGAP

DISTRIBUTION VALVE LIGHTNING ARRESTER

offers you the important ***EXTRA*** *of* UNSURPASSED DURABILITY VERIFIED BY A NEW CONCEPT OF ACCEPTANCE TESTING!



The exceptional durability and protective characteristics of Kearney Unigap Distribution Arresters have been thoroughly proven in an exhaustive program of service condition acceptance testing far more rigorous than present standards.

During this program, conducted at the Hubbard-Kearney Electrical Research Laboratory, Unigap arresters were subjected to unusually severe tests simulating actual service conditions and conclusively proved their capability to withstand some of the most severe conditions liable to be encountered in service. Unigap also proved to be the **only** arrester capable of successfully withstanding this complete series of acceptance tests.

Unigap Arrester durability and performance characteristics far exceed standards... discharge ability exceeds station arrester requirements...follow current interrupting ability is ten times normal service requirements.

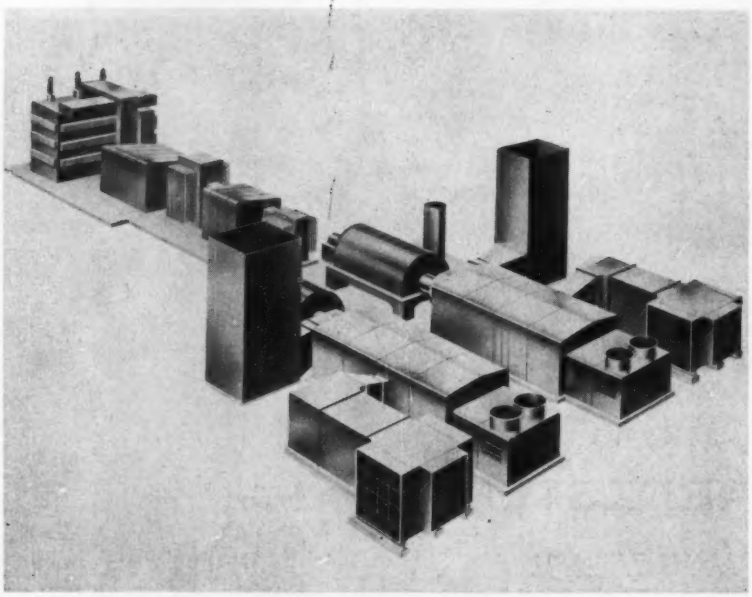
Consistently low sparkover and permanence of characteristics are insured by "unitized" spark gap construction combining both gap and separate coil functions in one rigid, precision assembly. Rapid magnetic arc movement and power follow current are accomplished without an auxiliary coil. An improved valve element limits power follow current to values perfectly matched to the interrupting ability of the gap structure.

For published results of Unigap acceptance tests and full information about this outstanding arrester, contact your Kearney Representative

KEARNEY **JAMES R. KEARNEY CORPORATION** • 4236 Clayton Avenue • St. Louis 10, Missouri

PLANTS IN ST. LOUIS • MELROSE PARK, ILL. • FAYETTEVILLE, ARK. • GUELPH, ONTARIO, CANADA • ST. THERESE, QUEBEC, CANADA

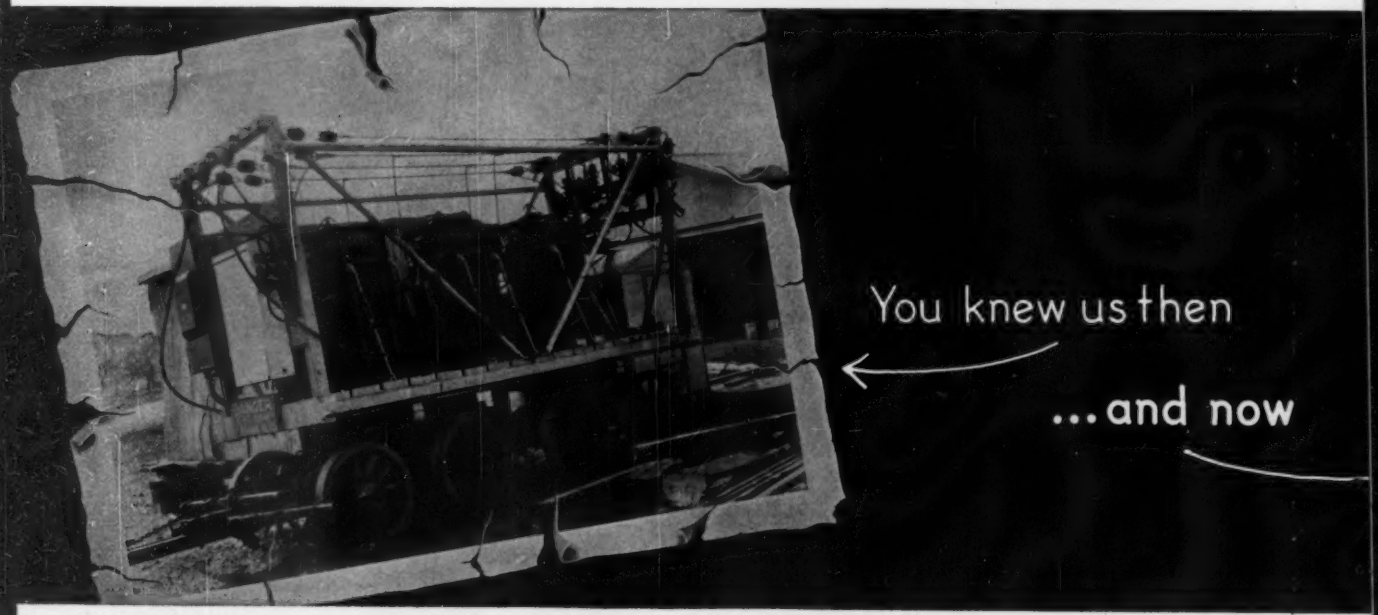
Unattended 55-Mw Gas Turbine Announced



GE REMOTE CONTROLLED GAS TURBINE peaking and base-load power plant as shown in artist's sketch is rated 55 Mw; is made up of package sub-assemblies

General Electric Co announced at last week's American Power Conference in Chicago the availability of a two-unit, 55-Mw output, outdoor, peaking and base-load gas-turbine power plant for remote-controlled, unattended operation. Rating is on a net station basis, including ducting, auxiliary, and power transformer losses. The plant combines two 28.5-Mw, single-cycle turbines, each direct-connected to a 35,294-kva, 3-phase, 3,600-rmp generator. Net 55-Mw rating is for NEMA conditions of 80F and 1,000-ft altitude.

The outdoor design is said to achieve low installed cost through maximum factory engineering and manufacturing content. Due to physical size and shipment limitations, the plant is composed of packaged sub-assemblies to be erected at the site—these are factory-tested before shipment. Field erection take 12 (single-shift, 40-hr) weeks.



Allis-Chalmers sets the pace for mobile substation progress

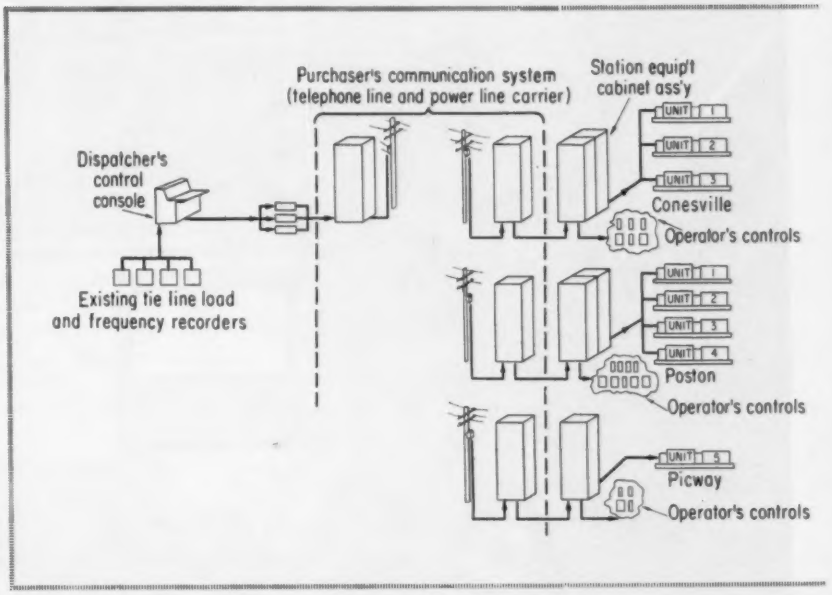
Remember this 12,000-volt "powerwagon"? Of 1930 vintage, it contrasts sharply with its modern-day counterpart — the compact, 20,000-kva mobile substation on the right.

Since these early pioneering efforts, A-C research, development and manufacturing have proved their maturity . . . *Contributing:* • Better insulations for switchgear to handle larger blocks of power in smaller cubicles • Distribution regulators offering greatly increased short-circuit protection • A-C nuclear power plant development to hasten the day when power from the atom is proven to be economically practical in more areas of the world • New A-C fuel cells that may soon offer a new source of electric energy • A-C

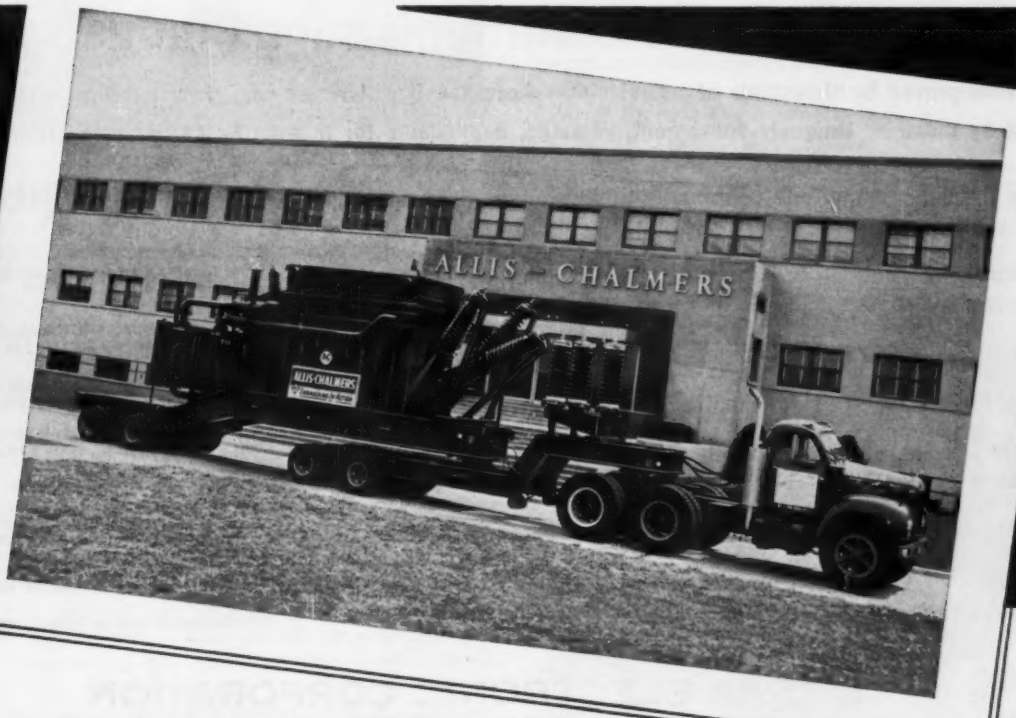
'Economic' Controller to Fix Multi-Plant Load

A contract for a Bailey 720 Economic Load Control System which will automatically control multi-plant power output to match demand has been received by Bailey Meter Co, Cleveland, Ohio. The load-control system will allocate the system generation to the units under control to achieve most economical operation. It will be installed at three plants of Columbus & Southern Ohio Electric Co.

The system will automatically control frequency and/or tie-line load, as well as distribution of load on incremental rate basis between eight generating units at three stations: Conesville, Picway and Poston. The master control and the system dispatcher's console will be located in the dispatcher's office in Columbus. Frequency-type telemetering over telephone lines and power line carrier will connect the dispatcher's office to the individual control equipment at the stations.



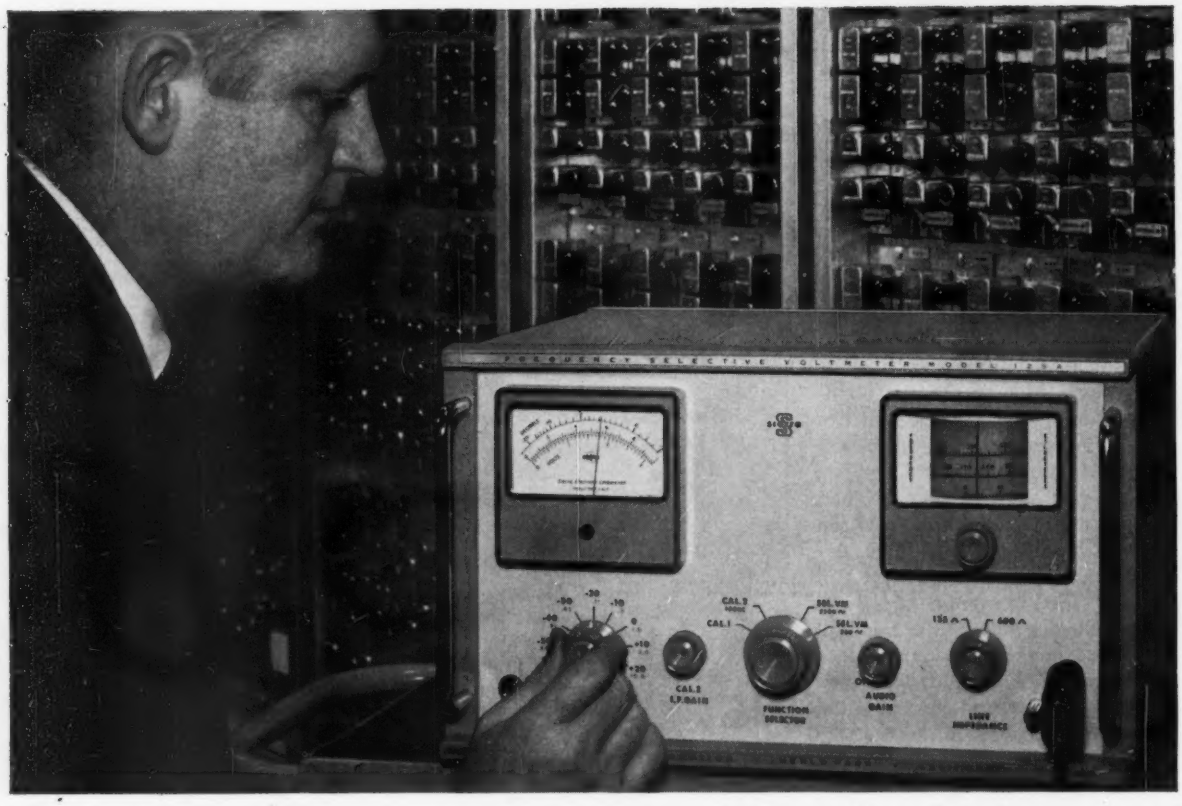
BAILEY LOAD CONTROL SYSTEM will control eight generating units at Conesville, Poston and Picway stations of the Columbus & Southern Ohio Electric Co



network analyzer facilities to assist utilities in solving present and future system load and stability problems.

In generation, in transmission, in distribution — Allis-Chalmers has helped America's growing utility systems set the pace in low-cost electric power. *For more information, write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.* A-1431

ALLIS-CHALMERS



Why is the Sierra Frequency Selective Voltmeter the standard of the communications industry?

Performance-proved by thousands of users! • Accepted by all major carrier systems manufacturers, specified by most! • Uniquely convenient, versatile, dependable for monitoring carrier modulation level!

- Single frequency band, one continuous tuning range—eliminates band switching
- Flat voltmeter section—for accurate measurement, easy detection of spurious signals
- Wide bandwidth—1 to 620 kc—covers 120 channels per L carrier allocation
- Coarse, fine tuning on a single knob—for greater convenience
- Crystal controlled calibration oscillator—for checking both frequency and level
- Domestically produced—for years-ahead engineering, rugged construction
- Dual selectivity—versatility for communications test, wave analysis, general lab use

SPECIFICATIONS
MODEL 125A

Frequency Range
Tunable Mode: 3 kc to 620 kc
Flat Mode: 1 kc to 620 kc

Measurement Range
Tunable Mode: —90 dbm to +32 dbm
Flat Mode: —30 dbm to +32 dbm

Selectivity
Narrow: Down 3 db 125 cps off resonance; down 45 db 500 cps off resonance
Wide: Down 3 db 1.25 kc off resonance; down 45 db 5 kc off resonance

Price $895.00, f.o.b. factory

Call your Sierra representative or write direct. Sierra Model 125B-CR, with upper and lower sideband carrier re-insertion, and Model 125B-Y, with patchcord connections for type "O" and type "N" Western Electric carrier, also available at additional cost.

Data subject to change without notice.

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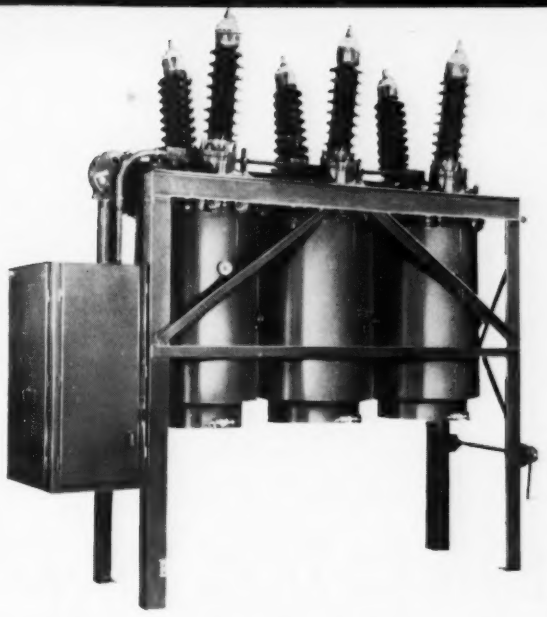
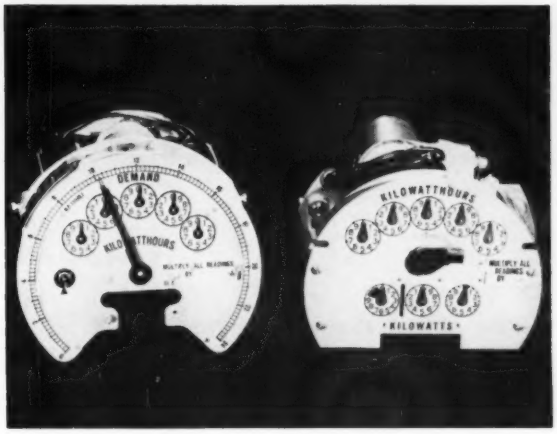
New Equipment

Power Circuit Breaker . . .

. . . has new-type interrupters, the Kool-Arc. The Type KM subtransmission breaker introduces design innovations not previously available in the 69-kv ratings: The interrupter is said to provide shorter arcing time and to reduce the degree of contact erosion and oil deterioration. The Kool-Arc tube is of high-strength, warp-proof, non-absorbent Fiberglas and epoxy construction. Over-all smaller size of the vertical interrupter is also said to assure greater internal clearances and to permit reduction in tank diameters. The breaker has a simplified breaker linkage system, improved operating mechanism, simplification of the conduit system for the transformer leads, and lower pull-rod housings which blend into the head.
I-T-E Circuit Breaker Co, Los Angeles 12, Calif.



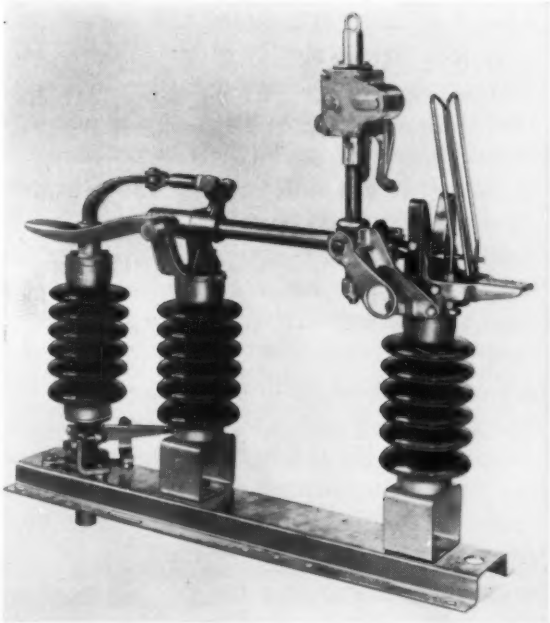


◂ Demand Register . . .

. . . replaces conventional sweep-hand design (left in photo) with three kwhr dials which offer a scale length 20 times greater. The new Type M-60 (EW, Sept. 19, 1960, p 128) can record the entire range of possible loads, unlike sweep-hand registers that require multiple scale-plate changings to register increasing loads. It combines the capacity of a Class 6 register with the accuracy and readability of a Class 1. Accuracy is within ±1% of all load points above 5% of register capacity. Calibration adjustments and scale classes are eliminated. M-60 can be installed on all GE magnetic-suspension single-phase and polyphase meters. It's available with time intervals of 15, 30 or 60 min.
General Electric Co, Schenectady 5, N. Y.

Load-Break Switch . . .

. . . offers power-class features for distribution switching equipment, 600 amp, 7.5, 15 and 23-kv. ARI-60 incorporates three insulator stacks with a vertical blade motion controlled by rotation of the rear stack. The blade first rotates on its own axis to relieve contact and then is elevated to open position. The switch's simple, 3-link blade mechanism is said to provide great mechanical advantage. The front contact is arranged to utilize the magnetic effect of increased current to build up contact pressure under short circuit. The Arc-KO interrupter unit utilizes a powerful spring, trip latch and plunger type of contact to interrupt current swiftly regardless of operator speed. The arcing chamber is lined with acrylic resin which produces extinguishing gases in a confined area designed to increase gas pressure during the critical blast period. A series-gap system forces cooled gas from the first contact break through the second contact area to increase the quenching action. Kearney says that the Arc-KO can be entirely replaced using a hot-stick—in less than a minute.
James R. Kearney Corp, Melrose Park, Ill.



OHIO BRASS MANAGEMENT REPORT

HOW TO TAME 750-KV WITH SECOND-HAND TIRE TUBES

BY GEORGE L. DRAFFAN
CHAIRMAN, OHIO BRASS COMPANY

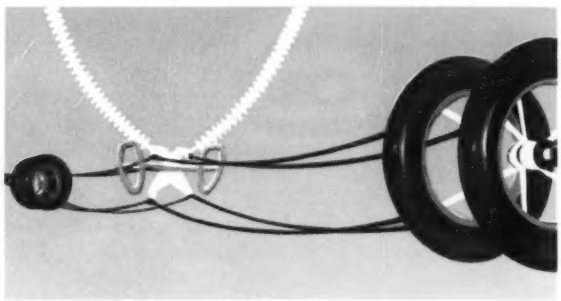
With betatrons, cyclotrons and multi-million-dollar computers now among the commonplace tools of research, we probably should be embarrassed to admit that second-hand tire tubes and dime store world globes have been highly valuable in our 750-kv research program. But I'll swallow my pride and tell the story because it shows there is still room for homely ingenuity in the electronic age:

OUTSIDE THE O-B HIGH VOLTAGE LABORATORY is what can accurately be called a one-million-volt test line. To be sure, it's only 80 feet long and has just one phase. But it can simulate the corona losses and radio interference voltage that would occur on a 1000-kv line.

A TICKLISH PROBLEM in measuring radio interference at such high voltages is to make sure you're measuring the right interference. If you are checking a suspension point, for example, you must find ways of subduing interference from all other points on the line.

IN TESTING MATERIALS for the 750-kv Apple Grove line, unwanted interference developed from two sources: the line carrying charging current from the 1500-kv transformer set to the test line and from anchor points at each end of the line. Here's how we subdued it:

TO GET A FLEXIBLE, CORONA-FREE LEAD from the transformer, two obvious solutions were avail-



able. A 6-inch diameter tube would work—but was discarded as bulky and expensive. Conductors could be bundled in four, six or eight units—too awkward. Instead, two dozen spheres were purchased from a maker of ten-cent store globes. They were laced on the conductor like beads and given a coat of O-B conducting paint. They increased the effective diameter of the conductor, so corona was eliminated from this source. Problem one solved.

HOW COULD RIV BE SUPPRESSED at test line anchor points? Here was need for a control device to expand the electrical field—to reduce concentration of electrostatic stress. Big metal rings are the conventional device. But we needed something with 50 per cent better performance than even 750-kv control rings. Rather than build jumbo metal rings, test engineers experimented by installing old rubber tire tubes around the critical points. Tubes were lightweight. They were easy to install. And they worked. It still seems strange to me, but tube rubber is a conducting material to the charging current required to put three-quarters of a million volts on the test surfaces. Problem two solved.

WE HAVE REALIZED TWO BENEFITS from this use of rubber tire tubes and dime store globes. First, we got the information needed. And second, when a visitor asks, "What on earth are those for?," we have a conversation piece good for at least 15 minutes.

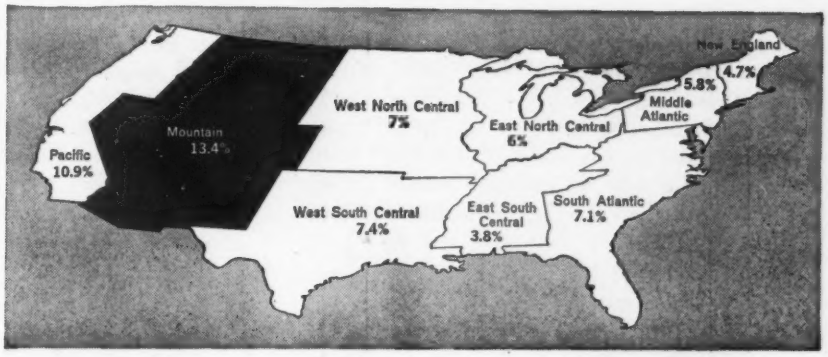
10146-H

OHIO BRASS COMPANY, MANSFIELD, OHIO
Porcelain Insulators – Line Hardware – Capacitors – Lightning Arresters Bushings – Holan Truck-Mounted Power Devices and Bodies – Bronze Valves

Electrical World

APRIL 3, 1961

Management Newsletter



Mountain States lead the way as . . .

Industry Net Income Shows 7.1% Gain in 1960

When all the dust had settled, 1960 shaped up as a pretty good year for a large chunk of electric utilities—in spite of a business slowdown and the uncertainties of an election year. Based on a sample of 144 companies, representing over 95% of total electric revenues for the industry, net income was up about 7.1% over that for 1959. Of course, the gain in the previous year had been some 9% for a similar sample, but 1959 was a record year. In all, seven out of eight companies in the sample showed gains in income over 1959.

Not all regions fared quite as well as the national average, however. In fact, regional performance was considerably different from that in 1959. Thus the Mountain states area, which racked up a gain of only 4.5% in 1959, the second lowest in the country, was way out ahead with a 13.4% gain in 1960. And the Pacific Coast area, low man on the totem pole in 1959, was running a good second in 1960, with a jump of 10.9% in its annual net income.

Hardest hit of the areas was the East-North Central section, the heavy industrial belt clustering about Lakes Michigan, Huron, Erie, and Superior. In 1959, this section was front-runner for the nation, with a fat 12.5% increase. But the substantial slowdown in the steel, metal-working, auto and other heavy industries that normally nourish this section's coffers took a lot of steam out of the net income rise and left the section in sixth place on the nine-area list. Running close behind it was the three-state Middle Atlantic area, where revenues from industry also play a critical role. The New England states, were down too. But so was the four-state area encompassing Alabama, Mississippi, Tennessee, and Kentucky, which has been second highest on the list of increases in 1959.

For the entire 144-company sample, increase in net income was over $114 million. Biggest single gainer was the giant Pacific Gas & Electric Co, with a boost of some $7.8 million. But running close behind was its neighbor, Southern California

Here Are Net Incomes for 144

(Thousands of dollars)

COMPANY	1960	1959	COMPANY	1960	1959
Alabama Power (a)	21,803	20,384	Fall River Electric Light (b)	923	1,008
Appalachian Power (a)	20,707	19,021	Florida Power	12,980	11,501
Arizona Public Service	9,387	7,878	Florida Power & Light	30,327	27,064
Arkansas-Missouri	1,392	1,277	Georgia Power (a)	22,155	21,091
Arkansas Power & Light (a)	10,755	9,282	Green Mountain Power	782	684
Atlantic City Electric	7,420	6,585	Gulf Power (a)	3,900	3,563
Baltimore Gas & Electric	21,952	20,966	Gulf States Utilities	16,279	16,023
Bangor Hydro-Electric	1,494	1,412	Hartford Electric Light	6,840	6,799
Blackstone Valley G&E (b)	1,922	2,080	Hawaiian Electric	4,270	3,837
Boston Edison	14,207	12,968	Housatonic Public Service	929	926
Brockton Edison	1,512	1,597	Houston Lighting & Power	22,483	20,923
California Electric Power	5,170	5,608	Idaho Power	8,808	7,762
California-Pacific Utilities	1,168	1,065	Illinois Power	20,837	19,421
Carolina Power & Light	13,549	13,194	Indiana & Mich Elec (a)	13,743	14,083
Central Hudson G&E	5,633	5,427	Indianapolis Power & Light	10,034	9,290
Central Illinois Electric & Gas	4,159	3,883	Interstate Power	4,513	4,358
Central Illinois Light	5,598	6,273	Iowa Electric Light & Power	5,216	4,837
Central Illinois Public Service	11,727	10,431	Iowa-Illinois Gas & Electric	6,339	6,373
Central Louisiana Electric	3,894	3,373	Iowa Power & Light	5,553	5,043
Central Maine Power	7,936	6,860	Iowa Public Service	4,425	4,300
Central Power & Light (a)	10,908	10,258	Iowa Southern Utilities	1,828	1,940
Central Vermont PS	1,836	1,741	Jersey Central P&L (a)	8,131	7,771
Cincinnati Gas & Electric	18,977	16,767	Kansas City Power & Light	10,856	10,281
Cleveland Electric Illum	21,399	21,166	Kansas Gas & Electric	7,535	6,981
Colorado Central Power	1,006	833	Kansas Power & Light	8,654	8,679
Columbus & Southern Ohio	9,230	7,700	Kentucky Power (a)	1,510	1,495
Commonwealth Edison	77,927	72,453	Kentucky Utilities	8,085	8,090
Community Public Service	2,058	1,886	Kingsport Utilities (a)	498	449
Connecticut Light & Power	14,298	13,564	Long Island Lighting	20,632	18,716
Consolidated Edison of N. Y.	71,836	68,764	Louisiana Power & Light (a)	8,391	7,577
Consumers Power	36,601	37,255	Louisville Gas & Electric	10,918	10,108
Dallas Power & Light (b)	10,937	9,270	Madison G&E	1,953	1,746
Dayton Power & Light	10,992	10,581	Maine Public Service	796	787
Delaware Power & Light	8,328	8,100	Metropolitan Edison (a)	9,312	9,177
Detroit Edison	38,457	33,430	Minnesota Power & Light	4,876	4,327
Duke Power	25,590	24,531	Mississippi Power (a)	3,592	3,465
Duquesne Light	22,472	21,446	Mississippi Power & Light (a)	5,864	5,749
Edison Sault Electric	316	338	Missouri Power & Light	1,992	1,701
El Paso Electric	4,173	3,756	Missouri Public Service	2,735	2,452
Empire District Electric	2,185	2,024	Missouri Utilities	758	648

Operating Electric Utilities*

(Thousands of dollars)

COMPANY	1960	1959
Monongahela Power (a)	6,613	6,532
Montana-Dakota Utilities	4,731	4,852
Montana Power	12,598	11,124
New England Elec System (c)	17,675	17,095
New England G&E (c)	4,641	4,302
New Jersey P&L (a)	3,143	2,730
New Orleans Public Service (b)	4,819	4,566
New York State E&G	15,618	14,998
Newport Electric	273	267
Niagara Mohawk Power	35,011	31,442
Northern Indiana PS	16,939	15,477
Northern States Pwr (Minn)	26,570	25,036
Northern States Pwr (Wisc)	3,357	3,308
Northwestern Public Service	1,222	1,255
Ohio Edison	29,581	28,038
Ohio Power (a)	22,910	21,153
Oklahoma Gas & Electric	11,375	11,311
Orange & Rockland Utilities	3,832	3,478
Otter Tail Power	2,369	2,578
Pacific Gas & Electric	92,565	84,737
Pacific Power & Light	12,164	10,053
Pennsylvania Electric (a)	18,145	17,791
Pennsylvania Power & Light	25,285	25,272
Philadelphia Electric	42,270	42,926
Portland General Electric	7,530	6,342
Potomac Edison (a)	5,201	5,186
Potomac Electric Power	16,562	14,582
Public Service Electric & Gas	46,339	39,244
Public Service of Colorado	13,809	11,526
Public Service of Indiana	15,903	16,367
Public Service of N. H.	5,600	5,453
Public Service of N. M.	3,794	3,302
Puget Sound Power & Light	7,466	7,267
Rochester Gas & Electric	9,869	10,061
San Diego Gas & Electric	9,943	8,821
St Joseph Light & Power	1,333	1,273
Savannah Electric & Power	1,875	1,665
Sierra Pacific Power	2,168	1,971
South Carolina E&G	8,448	8,093
Southern California Edison	50,980	43,395
Southern Indiana G&E	3,143	3,052
Southern Nevada Power	1,668	1,374
Southwestern Electric Power (a)	7,926	7,675
Southwestern Electric Service	487	483
Southwestern Public Service	10,943	10,075
Tampa Electric	7,045	5,605
Texas Electric Service (a)	18,399	17,304
Texas Power & Light (a)	15,463	14,355
Toledo Edison	7,104	7,089
Tucson Gas, Electric L&P	3,049	2,932
Union Electric	26,921	23,115
United Illuminating	5,764	5,537
Utah Power & Light	9,231	9,062
Virginia Electric & Power	30,506	28,178
Washington Water Power	6,447	7,114
West Penn Power (b)	15,626	14,854
West Texas Utilities (a)	5,180	5,076
Western Light & Telephone	2,203	2,020
Western Massachusetts	4,188	4,310
Wheeling Electric (a)	667	797
Wisconsin Electric Power	17,921	17,282
Wisconsin Michigan Power	2,192	1,678
Wisconsin Power & Light	8,537	8,410
Wisconsin Public Service	6,788	6,366
Total—144 companies	**1,719,458**	**1,605,088**

(a)—All common shares owned by a holding company.
(b)—Most common shares owned by a holding company.
(c)—Holding company controlling operating companies.

*** For the 12 months ended Dec. 31, 1959 and Dec. 31, 1960**

Changes from last year's 144 company sample: New England Electric System replaces seven NEES subsidiaries; Other additions include Duke Power, Madison G&E, Montana—Dakota Utilities, Public Service of Colorado, Southwestern Electric Power, and Wisconsin-Michigan Power

Edison Co, which pushed net income up more than $7.5 million from a considerably smaller base. Together, these two accounted for a large part of the Pacific area's good performance in 1960.

But other Pacific and Mountain area companies ran at least as well and in some cases better. In fact, seven of the ten utilities who racked up the greatest percent increases in net income were in the two Western regions, as shown in the tabulation below. To some extent, rate increases played a large part in these gains for the Western companies. Thus Arizona Public Service Co last year got an annual increase of about $330,000 and Public Service Co of Colorado one of about

These 10 Companies Made Largest Net Income Gains

Company	Percent Increase
Wisconsin Michigan Power	30.5
Tampa Electric	25.7
Southern Nevada	21.6
Pacific Power & Light	21
Colorado Central	20.6
Columbus & Southern	19.9
Public Service of Colorado	19.8
Arizona Public Service	19.2
Portland General Electric	19
Southern Cal Edison	17.5

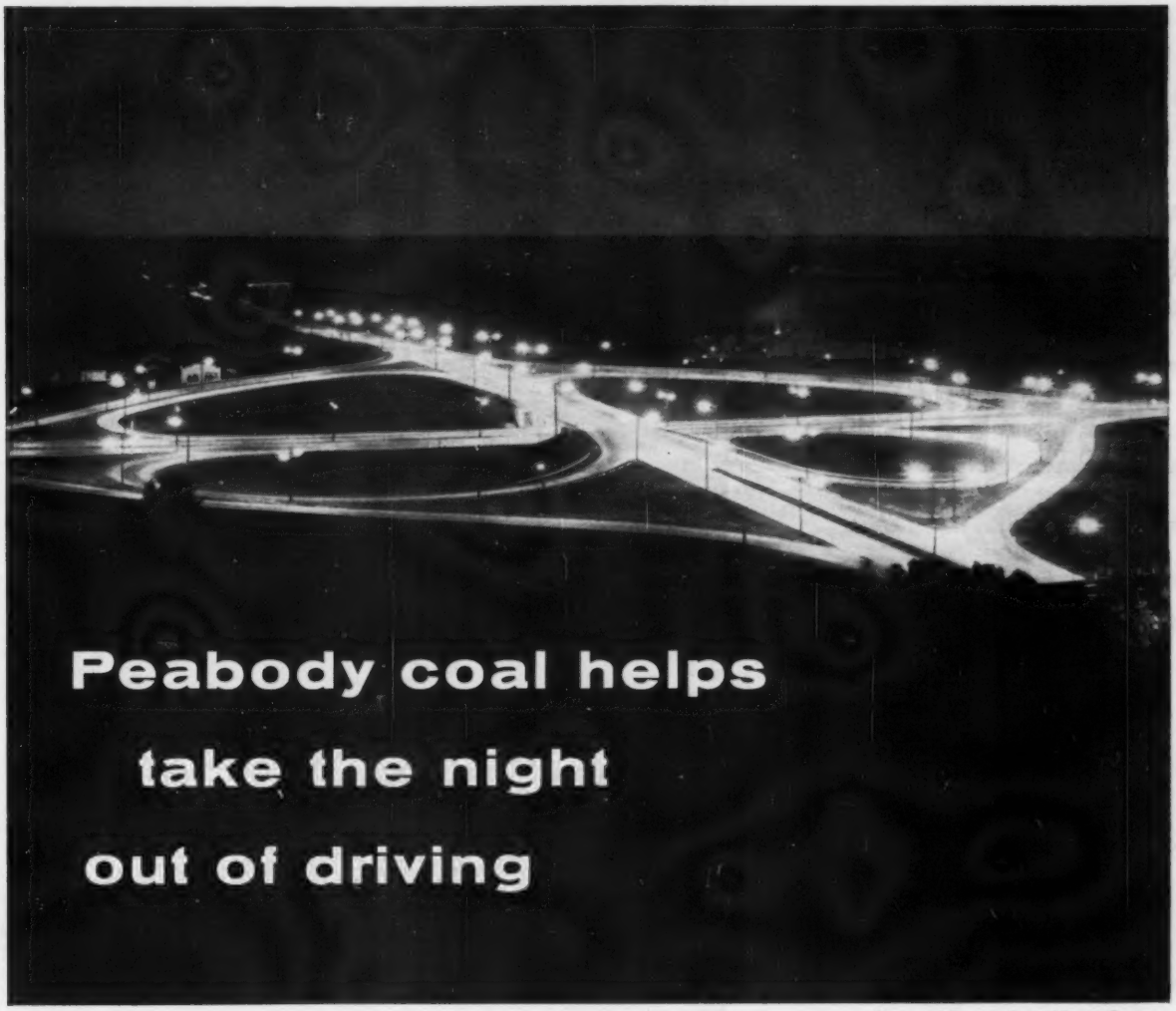
While These 10 Showed the Greatest Decline

Company	Percent Decline
Wheeling Electric	—16.3
Washington Water Power	— 9.3
Fall River Electric	— 8.4
Otter Tail Power	— 8.1
California Electric Power	— 7.8
Blackstone Valley	— 7.6
Edison Sault Elec	— 6.8
Iowa Southern Util	— 5.7
Brockton Edison	— 5.3
Northwestern Public Service	— 2.6

$3.2 million on electric rates plus a $1.2 million on gas revenues. Similarly Portland General Electric Co was granted a rate increase representing almost $2 million annually and Pacific Power & Light Co got over $3.5 million annually. Of course, Pacific P&L had racked up a 14.8% decline in net income in 1959, so some of its fat 21% gain in 1960 was only regaining lost ground. However, the West had its slow companies too. Thus California Electric Power Co, was still suffering the effects of a $370,000 annual cut in some of its residential rates imposed last year. But the other, Washington Water Power Co, could look for brighter prospects as a result of recent rate increases.

But not all the top performers were in the West. In fact, the biggest gainer on a percentage base was Wisconsin Michigan Power Co, with one recent rate increase and another one pending. Similarly, Columbus & Southern Ohio Co was, at year's end, absorbing one increase and had a request for a second one pending. Other utilities running well up, if not quite in the top ranks included Union Electric Co, Missouri Power & Light Co, Central Louisiana Electric Co, Missouri Utilities, Detroit Edison Co, Public Service Electric & Gas Co, Arkansas Power & Light Co and New Jersey Power & Light Co all with a 15% or greater increase.

All told, almost one-third of the sample made increases of 10% or more in 1960 net income compared to 1959. Included were 19 companies registering 15% or more and another 24 in the 10-15% range. Of the remainder, 36 companies showed increases of 5 to 10% and 47 utilities gains up to 5%. A total of 18 companies registered declines, ranging from less than 1% to over 15%.



Photograph Courtesy General Electric Company

Economical, Coal-Generated Electricity Saves Thousands of Lives by Making Night Driving Safer for You

One of the greatest safety devices developed in recent years is the *lighted highway*. When you whiz along a bright expressway, you probably don't realize that your driving safety has been increased by coal. Stabilization of coal prices has helped our great Electric Utilities provide you with *more* and *better* services at low cost.

On the highways, in your home, office and plant, day and night, coal serves you by generating dependable, economical electricity. Peabody Coal Company, with over two billion tons of proven reserves, supplies many of the nation's leading Electric Utilities that bring you this efficient power . . . at a price you can afford to pay.

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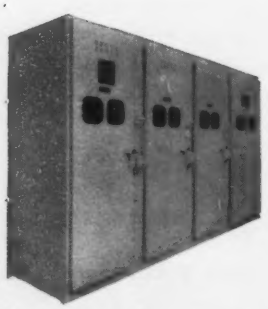
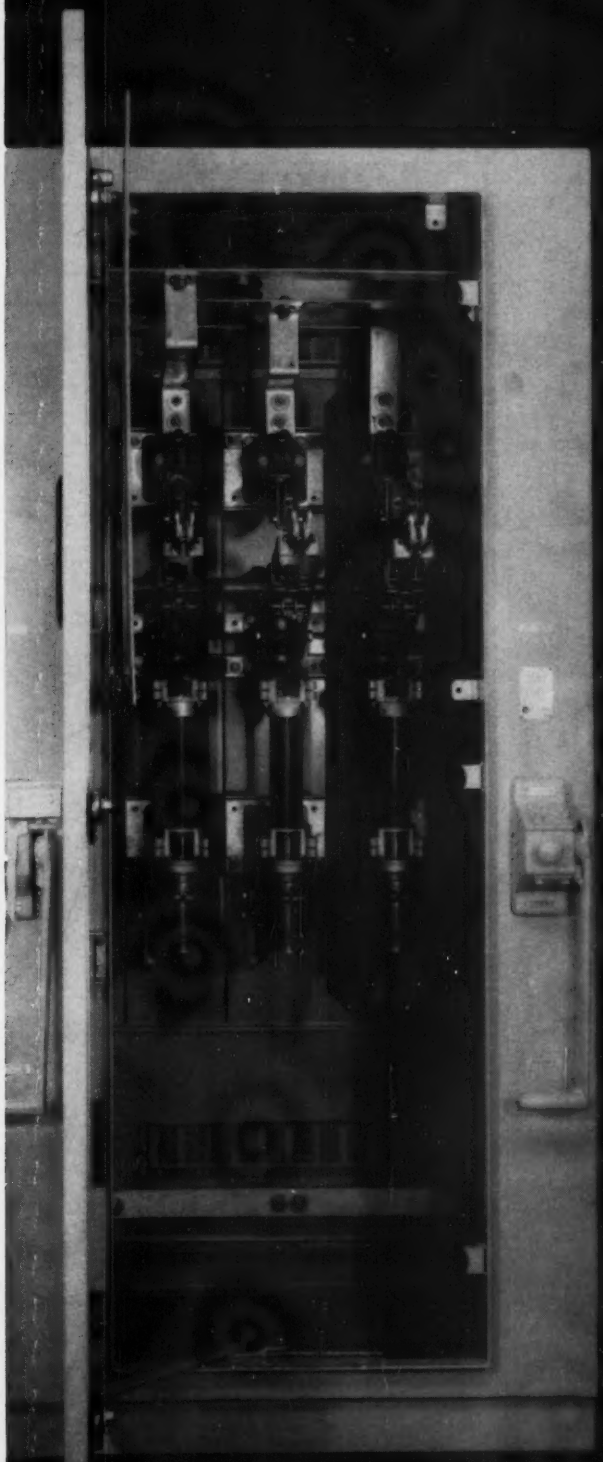
HOW SIMPLE CAN YOU GET?



S&C metalclad switchgear meets all National Electric Code requirements for fault closing, short-circuit interruption. Performance proved by high power testing at KEMA laboratories.

FUSE REFILLS



S&C metalclad switchgear is easy to operate, easy to maintain, easy to understand

The simplicity of the fused interrupters in S&C metalclad switchgear means that everyone from the consulting engineer to the electrical contractor to the plant engineer and electrician saves time, money, and effort. The power fuses give positive and permanently accurate protection against faults. The load interrupters provide full load switching and can close on any fault up to 60,000 amps (at 4.16 kv). The power fuse in series with the load interrupter takes the mystery and high cost out of high-voltage switch-gear for industrial plants and for commercial and industrial buildings.

Costing roughly half the price of comparably rated circuit-breaker equipment, S&C metalclad switchgear protects high-voltage power supply circuits with self-sufficient power fuses. Permanent faults are detected without the complicated relay systems or instrument transformers required with circuit breakers. (Transient faults do not occur on industrial or commercial power supply circuits. Thus the expensive repetitive and automatic reclosing features of circuit breakers are not needed.) After the fault has been corrected, simply replace the blown fuse with a $13.50 refill stored right in the enclosure door.

Operating instructions and installation are simple with S&C metalclad switchgear. Nothing to set, adjust, exercise or check out. Plant personnel find it easy to understand and operate.

Why not consider S&C metalclad switchgear for your high-voltage (2300 to 15,000-volt) power systems? For more information, please consult the telephone directory for your nearest S&C sales office. Or write to:

S & C ELECTRIC COMPANY

4421 Ravenswood Avenue • Chicago 40, Illinois

Specialists in High Voltage Circuit Interruption since 1911

S&C

Slash Maintenance Costs on Transmission Towers

Eliminate checking and re-tightening of nuts and bolts

•

Prevent outages due to loose hardware

Lock all nuts and bolts with

PALNUT® LOCK NUTS

Applied in seconds— Stay tight for life

PALNUT Lock Nuts are the lowest-cost, most reliable method of assuring permanently tight tower bolts, for these reasons:

- **Vibration-proof.** Unfailing double-locking spring action holds assemblies to original tightness.
- **Easy, fast assembly.** Light in weight, easily carried, free-spinning, quickly lock with ¼ to ½ turn of linesmen's wrench.
- **Weatherproof.** Heavily galvanized to equal or exceed ASTM specs. Still perfect after 30 years' service on many towers.
- **Low cost.** PALNUTS cost a trifle more than one cent in average sizes.
- **Small Space.** Need only 3 bolt threads.

Specify PALNUTS on all new towers —add them to existing towers. Send for Free Samples and data

THE PALNUT COMPANY

Division of United-Carr Fastener Corp.

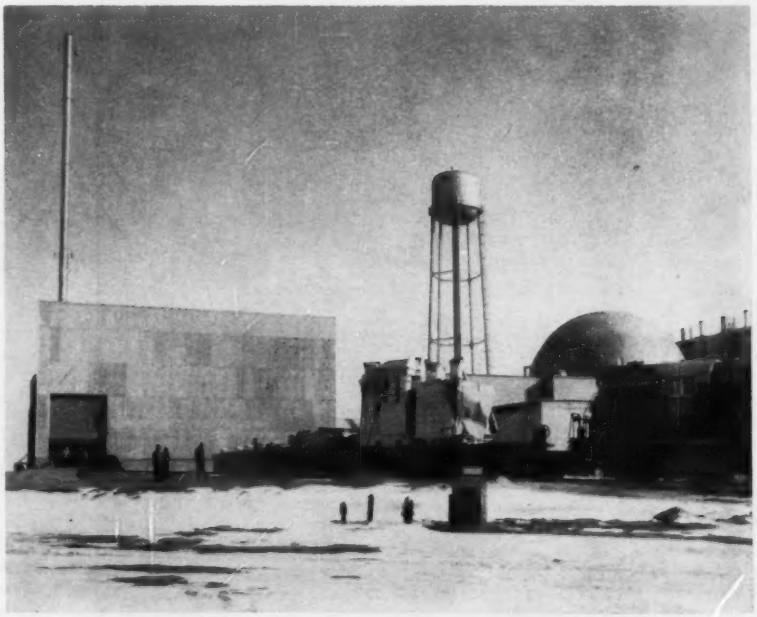
51 Glen Road **Mountainside, N. J.**

Treaty Ratification Nearly Unanimous

The proposed US-Canadian treaty for water and power development of the Columbia River has been overwhelmingly ratified by the US Senate. By a 90-1 vote, the Senate gave final US approval to the treaty, putting the whole matter to Canada.

The lopsided vote backed up an earlier unanimous recommendation for treaty approval by the Senate Foreign Relations Committee (EW, Mar. 20, p 54). The one dissenting vote in the Senate came from Sen Wallace Bennett (R-Utah) who said he was protesting the treaty as part of the "all-out public power policy of the new Administration." Bennett also noted that United Mine Workers Local 22 in his state is on record against the treaty because of fear that coal-generated power might be supplanted by hydro generation.

President Kennedy, in anticipation of Canadian ratification, asked Congress for a $350,000 supplemental appropriation to continue studies leading toward construction of a federal Libby Dam, on the Kootenai River, Mont. Libby requires Canadian approval, provided in the treaty, because it would back up water into British Columbia. The supplemental appropriation would be charged against the present (1961) fiscal year, ending June 30, and doesn't indicate the funds the Administration will seek for the coming fiscal year.



Enrico Fermi A-Plant Progress Shows

The last major component for the Enrico Fermi atomic power plant reaches the plant site near Monroe, Mich. The component, a 200-ton fuel transfer cask car, will transfer nuclear materials between the fuel and repair building at the left, and the dome-shaped reactor containment structure. It will shuttle through a 125-ft tunnel connecting the two buildings. About 85% of the car's weight is shielding material—lead and depleted uranium.

The Enrico Fermi plant, owned by Detroit Edison Co, is the world's largest breeder power reactor. When operating at full power, it will produce about 20% more new fuel in the form of plutonium than it will use in the form of uranium-235.

Rugged and Dependable

CONDUCTORS
Solid annealed copper, 22, 19, or 16 ga. ASTM designation B-3.

INSULATION
High molecular weight polyethylene, color-coded with compounds to insure electric balance and permanency.

CABLE ASSEMBLY
Varying core constructions available in single insulated conductors, pairs, triples, quads, or composite groups to customer and industry specifications.

CORE COVERING
Non-hygroscopic core tape.

JACKET
Black, high molecular weight extruded polyethylene. Tough and flexible, the jacket withstands exposure to sunlight, temperature extremes and ground chemicals.

SHIELD
Corrugated, longitudinally applied, 5-mil copper tape.

FOOT MARKED
Cable available upon request with sequential foot-marking every two feet.

SUPERIOR Supervisory Control Cable

Quality-constructed SUPERIOR Supervisory Control Cable, type SUP, is specifically designed for electronic control and communication circuits in modern power plants. Rugged and dependable SUPERIOR SUP Cable provides top operating efficiency, economically.

Write for complete details to

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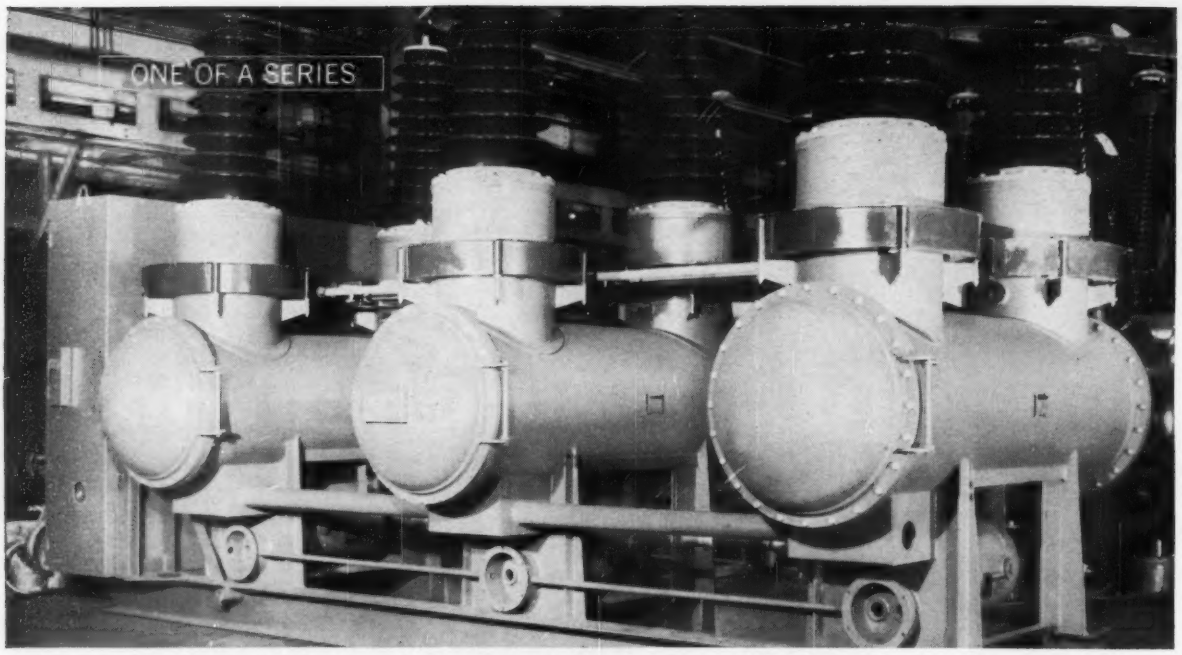


Relative light weight of SF_6 breaker and virtual elimination of ground shock reduce foundation requirement to a small fraction of that required for equivalent liquid-filled breaker.

Lightweight, Closed Gas System of SF_6 Breaker Trims Installation Costs, Reduces Operating Costs

. . . provides greatly improved performance from 69 to 460 kv and beyond

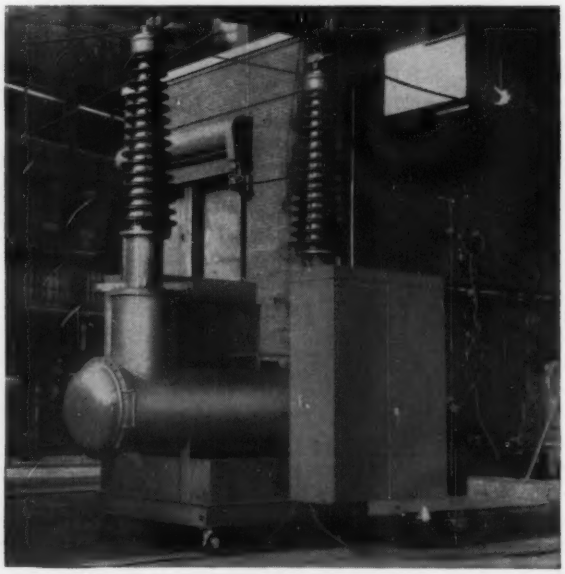
Design Permits Simplified Installation

Compactness of the revolutionary new Westinghouse gas breaker design permits shipment to most locations of the completely assembled 3-pole unit in ratings through 230 kv.

Unusual dielectric strength of the SF_6 (sulfur hexafluoride) interrupting medium permits minimum live-part to dead-tank clearances never before possible.

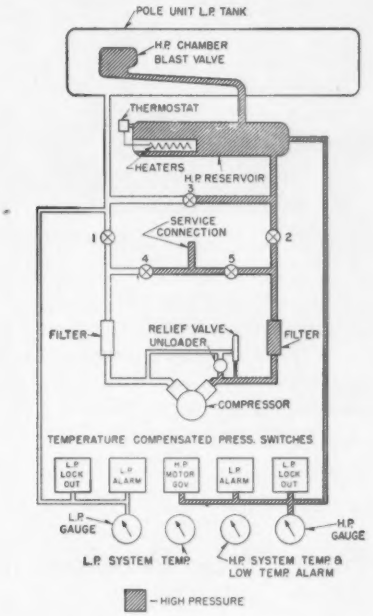
Foundation shock is eliminated because shock pressures associated with arc interruption are absorbed in the SF_6 gas dielectric. The picture at right shows a test pole-unit at the Westinghouse High Power Laboratory.

Note the lightweight, unanchored, wheeled cart supporting the tank. During heavy fault interruptions there was no breaker demonstration . . . only the swing of the overhead cables and the sound of mechanical operation. The breaker itself remained motionless.



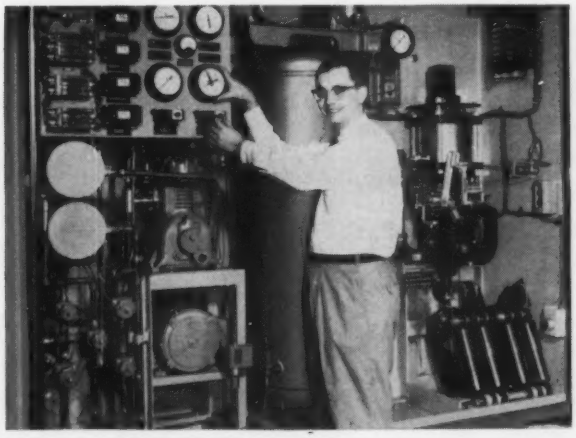
Sealed Design Assures Economy

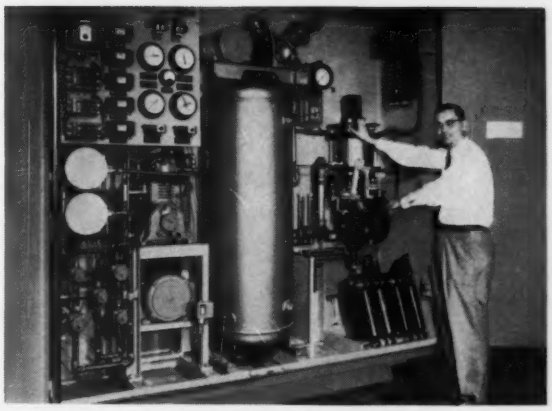
In the Westinghouse SF_6 gas breaker, a completely sealed system is used to conserve the gas used during operation. Normal gas pressure inside the pole units is maintained at a nominal 40 psig.



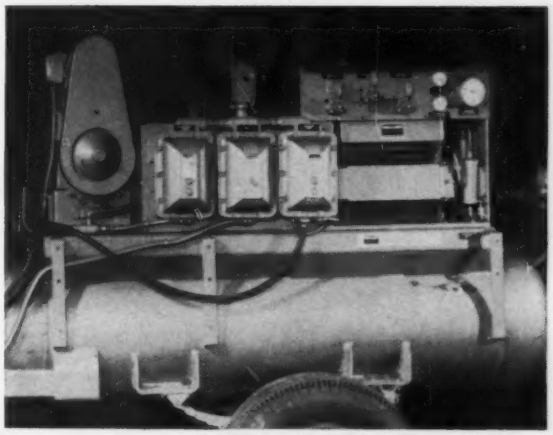
High pressure gas at 220 psig is used to extinguish the arc drawn in interruption. Gas for this operation is stored inside the pole units in a high pressure chamber. Reserve capacity is stored in individual high pressure tanks located below the main pole tanks.

The gas control system, shown below, is located in a weatherproof housing mounted on the breaker base. Temperature-compensated pressure switches operate the compressor motor to maintain high and low pressure systems at proper levels. A filtering system of activated alumina absorbs the minor by-products of arc decomposition.





A standard pneumatic mechanism, long used in Westinghouse breakers, closes the breaker contacts and compresses the accelerator springs which open the interrupter contacts. A semaphore-type mechanical position indicator shows whether breaker is opened or closed.

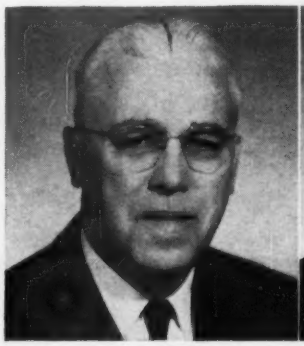


Seven standard size cylinders of SF_6 gas are all that are needed to charge a 230-kv breaker system. A gas handling cart, shown here, is available for temporary storage of gas during inspection and maintenance.

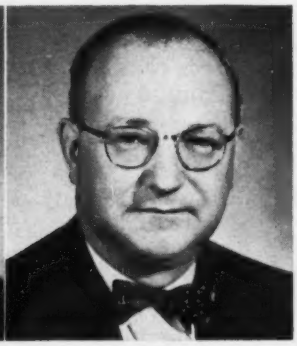
Get the facts about the additional savings in installation, operation and maintenance with the new SF_6 gas breaker . . . call your Westinghouse sales engineer. Or, write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania. *You can be sure . . . if it's Westinghouse.* J-61010

Westinghouse

Chairman of Board And President Are Appointed at CILCo



BABCOCK



HATHWAY

Central Illinois Light Co has elected William W. Babcock chairman of the board and George W. Hathway president. They succeed Earl D. Edwards who retired as chairman and president.

With Central Illinois Light more than 30 years, Babcock started as an efficiency engineer. He moved up through the ranks and, in 1951, became assistant to the vice president of sales, public relations, and rates. Babcock has been a vice president since 1955.

Hathway started with CILCo in 1932 in the gas service department. He was elected a vice president in 1951 and became executive vice president in 1956.

Llewellyn Becomes Arizona Public Service Vice President

◀ MAX R. LLEWELLYN

Max R. Llewellyn has been named a vice president of Arizona Public Service Co. He will continue as manager of gas and electric operations.

Llewellyn joined Arizona PS' predecessor utility, Arizona Edison, in 1947 as general superintendent of operating and engineering. Prior to that he had served as engineer for a California utility in Burbank.

Finn Named Worthington Vice President-Group Executive

Worthington Corp has elected William A. Finn vice president-group executive. A. Edwin Carter, vice president-manufacturing, succeeded Finn as general manager of the Harrison, N. J., division.

Finn came to Worthington in 1926. Following five years in the Navy, he returned to Worthington in 1946 as general manager of European operations. He was named general manager of the Holyoke, Mass., division in 1955, and general manager of the Harrison division in 1960.

WILLIAM A. FINN ▶

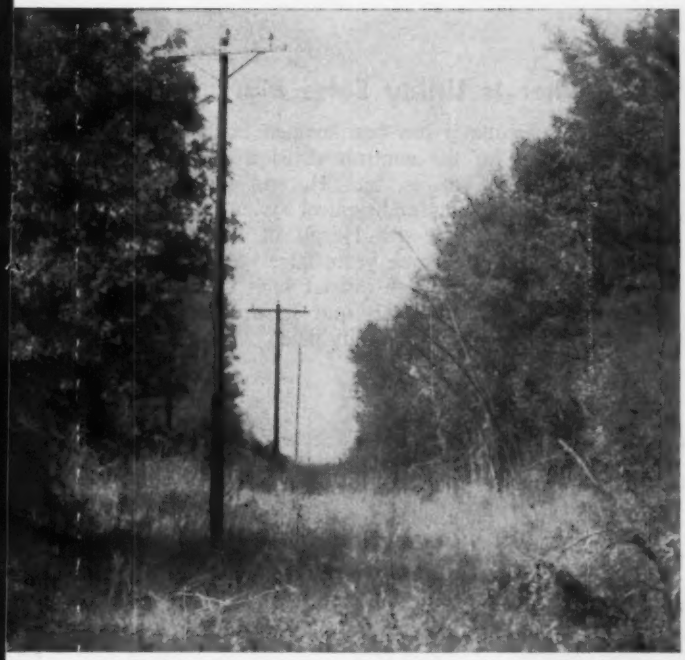
(*More News About People on page* 78)

Control brush safely...even near sensitive crops

Use non-volatile

DU PONT AMMATE® X

weed and brush killer



This right-of-way was sprayed with Du Pont "Ammate" X four years before the photograph was taken. Long-term control of brush, like this, results in lower maintenance cost on rights-of-way.

Sensitive crops are not exposed to vapor damage when you spray with "Ammate" X. Photo taken 45 days after spraying shows brush at left under control without injury to tobacco at right.

To control brush thoroughly and safely—even where your right-of-way is adjacent to sensitive crops such as tobacco, cotton, peanuts, tomatoes, grapes and soybeans, spray non-volatile Du Pont "Ammate" X weed and brush killer. Many power companies have used it for years without a single crop-damage claim.

"Ammate" X offers you big savings, too, because it gives long-term brush control. After the original spraying, you only have to *spot-spray* in subsequent years.

For more information on "Ammate" X—and all other Du Pont Weed and Brush Killers—write E. I. du Pont de Nemours & Co. (Inc.), Industrial and Biochemicals Dept., Room 2543-N, Wilmington 98, Del.

On all chemicals follow labeling instructions and warnings carefully

DU PONT Weed and Brush Killers

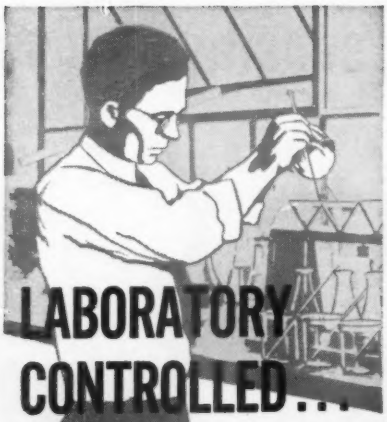
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

Control brush with dry, non-volatile pellets of Du Pont DYBAR®

fenuron weed & brush killer

A single application of easy-to-use "Dybar" pellets cleared this Maine Public Service right-of-way of conifers and hardwoods. "Dybar" is effective and economical to use. It can be applied as a basal, grid or broadcast treatment any time except when the ground is frozen. For best results apply in late winter or early spring.



LABORATORY CONTROLLED...

Crapo

GALVANIZED STEEL STRAND FOR GUY, MESSENGER and OVERHEAD GROUND WIRE

The high, uniform, consistently-dependable quality of Crapo Galvanized Steel Strand is the direct result of close laboratory control over each step in manufacture. All wires used in forming a particular size and grade are produced from steel of selected analysis, carefully processed under technical supervision and stranded on precision machines. Both wire and finished strand are subjected to prescribed laboratory tests to insure the desired end result.

Heavy, uniform, tightly-bonded zinc coatings, applied by the famous Crapo Galvanizing Process, provide maximum resistance to corrosion.

Write for booklet OG-25 containing "Sag and Tension Data for Overhead Ground Wire."

INDIANA

STEEL & WIRE CO., INC., Muncie, Indiana

Smith Appointed Senior Partner

Frank V. Smith has succeeded Alf Kolflat as senior partner of Sargent & Lundy, Chicago consulting engineers, who retired.

Smith has been with S&L since 1927. He became a partner in 1945. He was chief electrical engineer from 1946 to 1953 and has been general manager since 1954.

Kolflat had been a senior partner since 1954. He joined the staff in 1925 and was admitted as a member of the firm in 1938.

Faulkner Is Utility Sales Manager

L. M. Faulkner has been named manager of utility sales for the controls division of Hagan Chemicals & Controls, Inc. He will coordinate sales of instruments and control systems.

Faulkner started with Hagan in 1953 as a service engineer. Three years later he was promoted to the Pittsburgh district sales office and specialized in instruments and controls systems for the steel and public utility fields.

Sears Succeeds Reinhold As CL&P Purchasing Agent

Herbert W. Sears has been named to succeed Frank M. Reinhold as purchasing agent for Connecticut Light & Power Co. Reinhold, who was also a vice president, retired.

Sears (photo) joined CL&P in 1941 in the stores department. In 1948 he became purchasing assistant, the post he held until recently.

Central Vermont PS Names Edson as Chief Engineer

Wayne M. Edson has been appointed chief engineer and manager of operations for Central Vermont Public Service Corp.

Edson had been superintendent of operations since 1937. In his new post, he assumed engineering and operating responsibilities formerly held by Harold L. Durgin, executive vice president. Edson reports to Durgin, the company's chief administrative officer.

Before joining Central Vermont PS, Edson was administrative electrical engineer with predecessor companies of Niagara Mohawk Power Corp.

Federal Pacific Marketing Position Goes to Stimpson

Bradford J. Stimpson has been promoted to marketing manager-power circuit breakers and power switching equipment for Federal Pacific Electric Co.

Starting with Federal Pacific in 1947 as an inside salesman, Stimpson became a utility salesman in the company's Seattle office. In 1955 he was named Los Angeles assistant district sales manager and, in 1958, utility sales manager. Stimpson was assistant marketing manager-circuit breakers and power switching equipment before his promotion.

(*More News About People, p* 80)

ACCURACY PERMANENTLY ASSURED BY TAUT BAND SUSPENSION

New Westinghouse Switchboard Instruments

give you the proved benefits of Taut Band Suspension in your choice of 4½″ full view 250° scale or 6″ rectangular 100° scale designs.

Westinghouse a-c and d-c Taut Band Suspension instruments offer you definite advantages over pivot-jewel bearing types. They have no friction; provide higher sensitivity; offer almost infallible repeatability; are more durable, requiring less instrument repair and replacement. Accuracy is not affected by severe vibration or shock — an important factor in eliminating instrument damage during shipment of individual units or complete switchboards.

This outstanding performance is the direct result of Westinghouse *tbt**—the remarkable suspension system that has proved its superiority over the past two years in all types of applications. For complete details on these new instruments and a sample of Taut Band Suspension, write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. You can be sure . . . if it's Westinghouse.

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PERSONAL BRIEFS

Glover P. Fallon has been chosen by Baltimore Gas & Electric Co to be chief engineer in the electric division, succeeding **G. S. Harris** who retired. **Warren E. Bittrick** became an electrical engineer in the electric engineers department, and **Wallace MacWilliams Jr** became assistant to the vice president-engineering and construction.

Gulf States Utilities Co has promoted **James S. Turner** to system supervisor of advertising in Beaumont.

James Richard Van Dover has joined Arkansas State Electric Cooperative, Inc, as assistant to the general manager.

Patchogue Electric Light Co has named **Ira Rogers** manager of business development; **George Vedder,** manager of advertising and promotion; and **William Glatzel,** head of a new service department for application of electrical appliances and equipment.

W. J. Rose, vice president and secretary of American Electric Power Co, has been elected to the board.

Duke Power Co has elected **John D. Hicks** secretary.

Fenton W. Varney has become commercial and industrial sales manager of Narragansett Electric Co. Varney succeeded **Frank W. Caulfield.**

Western Massachusetts Electric Co has elected **Edward T. Augustine** assistant vice president. **Russell D. Purrington** became superintendent of production, responsible for steam and hydro stations.

Terry Moynihan has been named manager of Kit Carson Electric Cooperative.

West Penn Power Co has promoted **Gordon B. Hoffman** to manager of planning engineering, and **Fred J. Funari** to personnel director.

Cecil H. Kirk, vice president in charge of electric operations for Montana Power Co, has succeeded **T. L. Doran** who retired as vice president in charge of operations. In addition to his present duties, Chief Engineer **Ray M. Ball** has assumed responsibility for special projects. **Carl R. Davis** was promoted to engineering department manager; **Roger A. Hofacker** to assistant manager of the engineering department; and **Dan H. Pyfer** to purchasing department manager.

Pacific Power & Light Co has appointed **Orren Brownson** division manager responsible for service operations in the metropolitan Portland area.

Pacific Gas & Electric Co has named **Norman M. Scofield** manager of line construction, replacing **Harold D. Wright** who retired.

General Electric Co has recently appointed **Paul H. Zeanah** as manager of operations for the Vallecitos boiling water reactor at Vallecitos atomic laboratory. **Jose E. Sandor,** former member of Argentina's Atomic Energy Commission and the National Research Council of Canada, has become a physical chemist in GE's advanced semiconductor laboratory. **George H. Hupman** was named manager of marketing for the power transformer department. **Charles Concordia,** manager-general analytical engineer in the electric utility engineering operation, was named chairman of the study committee on power system planning and operation of the International Conference on Large Electric Power Systems.

William W. Smith has succeeded **J. Donald Moulton** who retired as manager of engineering and development for Electric Storage Battery Co's nickel-alkaline battery division.

At Allis-Chalmers Manufacturing Co's Terre Haute, Ind., works, **Ballard M. McKinney** has succeeded **B. F. Coleman** as works manager and **M. P. Schmidt** has replaced **Orval T. Neuenfeldt** as works comptroller. Coleman and Neuenfeldt were transferred to the international division.

Robert O. Boden has been named

Electric Autolite Co's Decatur, Ala., plant manager.

Carl O. Young has been appointed manager-lamp parts department of the Westinghouse Electric Corp lamp division.

Robert S. Senator has become manager-systems engineering laboratory for Philco Corp's computer division.

Minneapolis-Honeywell Regulator Co has promoted **Wallace Martin Jr** to personnel manager for the Boston division, succeeding **Bruce Bunten** who resigned.

Square D Co has appointed **Walter R. Clarke** product manager in the marketing division.

Okonite Co, subsidiary of Kennecott Copper Corp, has established branch offices in Denver and in Charleston. **James F. Angle** heads the Denver office, and **John P. Oblinger** heads the Charleston, W. Va., office.

General Cable Corp has appointed **S. E. Yeaton** assistant vice president.

F. D. Lapham has become general administrative manager of electromotive division of General Motors.

Daniel P. Ross has been promoted to senior engineering specialist in the Tapco Group research department of Thompson Ramo Wooldridge Inc.

OBITUARIES

Everett H. Maxcy, 72, director and retired vice president, Central Maine Power Co . . . **Claude A. Connell,** 55, Smackover plant manager, Arkansas Power & Light Co . . . **John Edward McAuliffe,** 69, founder and chairman, Triangle Conduit & Cable Co, Inc . . . **John B. Mullen,** 92, founder of Mullen Electric Co . . . **William M. Jewell,** 66, Western region manager for National Assn of Electrical Distributors . . . **William O. Kyte,** 49, advertising and sales promotion manager, General Electric Co's apparatus sales division, Pacific Southwest district.

First in Performance Values

SLOW DISK SPEED (10 rpm at rated load) minimizes the effect of current damping on high loads and inherently requires less compensation to produce a more uniform registration curve.

HIGHEST TORQUE (from 10 to 100% above other meters) produces better stability . . . more uniform registration . . . more accurate light load performance. Especially helpful when demand registers, cyclometer registers or contacts are used.

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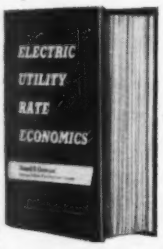
COMPARE disk speed, torque, watts loss, temperature compensation. To these features, add the superior magnetic moving system. That's the J3, first in performance values.

SANGAMO ELECTRIC COMPANY / *SPRINGFIELD / ILLINOIS*

How electric utility rates are established—

the complete story, from economics and technology to rate-department operations, clearly presented for all in the utility and regulatory fields.



Here is a concise and practical guide to the art of electric rate making, offering a practical approach to the operating utility in meeting the day-to-day requirements of the business. The basic principles covered apply equally well to telephone, gas, steam, water, and electric railway companies. The book fully covers basic electric utility economics: regulation, competition, earnings, revenues and expenses, public and employee relations, etc. Appropriate charts, diagrams and tables help provide a detailed analysis of the price structure and its end result, the tariff, or practical means of charging for service. The principal rate forms and schedule provisions in use today are described and there are worked-out examples of bill calculations and full cost adjustment.

ELECTRIC UTILITY RATE ECONOMICS

By Russell E. Caywood

Manager of Rates, West Penn Power Company

236 pages, 6 x 9, 60 charts and tables, $10.00

"A worthy addition to the literature of electric utility rates . . . a practical book which should appeal to the practical man."
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American Gas Association Monthly

Over seventeen different rate classes are described as well as such miscellaneous rate practices as optional, class, promotional, objective, zone, and submetering. Under the heading of earnings is included a consideration of those elements, namely, utility plant, depreciation, and rate of return, which are essential in determining the rate increase or rate decrease which is to be effected in a rate modification program. This book, written by a noted rates manager, besides supplying fundamentals of the electric utility business, brings together under one cover the general knowledge of engineering, accounting, sales operations, statistics, law, etc., that you need for successful rate work.

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Selling

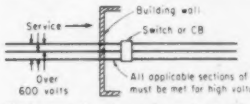
Atlanta Electrical League is sponsoring a one-day conference on street lighting. To be held at the Atlanta Biltmore on April 19, the meeting will be aimed at emphasizing the user benefits of street lighting . . . **Saying, "Remember The Alamo"** may soon be changed to "Remember the Alamo Is Heated and Cooled." Three all-electric heat pumps will soon be installed at the Texas shrine; all equipment and wiring will be camouflaged . . . **Consolidated Edison Co of New York** is running a series of ads with a "man on the street approach." Titled, "Con Edison listens to (name of person)" ads disclosed that seven out of ten people thought electricity and gas were fairly priced; only four out of ten knew electricity and gas prices are regulated by the Public Service Commission; and only two out of ten thought Con Edison digs up the streets too much . . . **Edison Electric Institute** is launching a national advertising and promotion campaign to increase the efficient use of electricity on the farm. Campaign will kick off with two-page magazine advertising spread in April . . . **Capehart Housing Project** at Selfridge Field Air Force Base, Mount Clemens, Michigan, will have 380 all-electric homes. Total electric bill per unit will be about $23.50 a month. Air Force chose all-electric installations because of first cost economy and reduced maintenance cost . . . **National Rural Electric Cooperative Assn** predicts a $1-billion rural market for appliances this year. Assn puts rural electric potential sales at 2,148,400. Estimated industry sales are now 11,720,000 . . . **First thermoelectric refrigerator-freezer** for commercial sale has been introduced by Norge Division, Borge-Warner Corp. Five hundred units will be installed in rooms of new Sheraton-Chicago . . . **Oklahoma Gas & Electric Co** is offering a special $35 allowance to any customer who replaces a flame-type tank with a new quick-recovery electric water heater. Special claim cards will be made available through dealers. Campaign will run for three months.

CONSTRUCTING ELECTRICAL SYSTEMS

By J. F. McPartland and the Editors of Electrical Construction and Maintenance

Here's a modern, comprehensive reference and instruction manual on the methods and techniques used in constructing systems for power, light, signals and communications. Covering the best practice on selecting, mounting, connecting and housing all types of electrical equipment, **this manual presents 1959 National Electrical Code data relating to installation. And a wealth of special illustrations are used throughout to clarify fine code points.**

CODE RULES ON HIGH-VOLTAGE SERVICES


Service
Building wall
Switch or CB
Over 600 volts
All applicable sections of Art. 230 must be met for high voltage service.

Conductors and equipment for services rated over 600 volts between conductors must basically comply with applicable sections of Article 230 on services up to 600 volts. It should be noted that, for purposes of code application, secondary conductors, not the primary conductors, are regarded as constituting the service conductors to the building proper where: (A) Step-down transformers are located outdoors; (B) Step-down transformers are located in a separate building from the one served; or (C) Step-down transformers are located in the building served, in a transformer vault meeting code rules on construction of such vaults and under sole control of the supply company.

Chapters are broken down on the basis of types of equipment to facilitate ready reference: lighting equipment – motors and controllers – conductors – raceways – switches – overcurrent protective devices – switchboards and panelboards – transformers – capacitors and regulators – power sources – high voltage – signals and communications.

"Constructing Electrical Systems"
Electrical Construction & Maintenance
330 West 42nd St., New York 36, N.Y.
(PRINT)

Please send me ___ copy(copies) of the book, "Constructing Electrical Systems," at $4.50 each.

☐ Payment enclosed.
☐ Please bill me.
☐ Bill Company.

Ship to:
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Company Name _____
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Address—Company ☐ _____
City _____ Zone ___ State ___
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MULTI-AMP ELECTRONIC CORPORATION
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P-6319, Electrical World
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RENUBILT MOTORS - GENERATORS
TRANSFORMERS - CIRCUIT BREAKERS
DO YOU GET OUR STOCK LIST?
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OL-3-3334

TRANSFORMERS FOR SALE
3—Uptegraff 500 KVA, 1/60, 2400 primary, 120/240 secondary, will reconnect 240/480, 4—2½% BN Taps, Pyronal or oil filled, O.I.S.C., Late Style, Guaranteed.
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Your Inquiries to Advertisers Will Have Special Value . . .

—for you—the advertiser—and the publisher, if you mention this publication. Advertisers value highly this evidence of the publication you read. Satisfied advertisers enable the publisher to secure more advertisers and—more advertisers mean more information on more products or better service—more value—to YOU.

Cement Plant Expansion Stresses Flexibility (*Continued from page* 48)

table-machine frame-to-ground voltages to safe levels during ground faults. A 96-ohm continuously rated neutral resistor limits the maximum single-line-to-ground fault current to 25 amp. To minimize voltage surges on the safety ground wire from primary ground faults and lightning surges, the safety register ground grid is 50 ft from the arrester and substation ground grid.

The ground wires included in the shovel cables attach to frames of the portable equipment from the safety ground point. Frame-to-ground voltages are held below 50 v during single-line-to-ground faults with a ground wire of less than 2 ohms impedance.

Portable switchhouses, cable-fed from the quarry substation, are located 1,000 ft from the portable shovels. A disconnect switch in each switchhouse provides a visible means of circuit isolation, while an oil circuit breaker permits automatic isolation of faults. Each switchhouse uses a balanced-flux 3-phase current transformer and ground instantaneous relay to isolate ground faults down to 5 amp. Phase relaying consists of long-time induction-disc relays to override the shovel m-g set accelerating inrush and yet provide some measure of cable protection.

Automation of cement plants has dictated that controlling and recording meters be used for practically every part of the automatic operation. Operating practices require both indicating and recording meters for on-the-spot checks of the process, and cost accounting systems insist that the departmental charges be accurate for each type of product produced. Thus, these instruments are usually the recording-controlling type and also serve as indicating instruments.

Taking into account the electric power meters, Lehigh's practice is to install the departmental kwhr meters on each metalclad switchgear unit. Meters on the low-voltage systems are also used. Kilowatthour meters are also installed on each raw and clinker grinding-mill drive to indicate energy consumption for grinding the various types of materials without taking into account the mill auxiliary equipment.

Lehigh's practice is also to use metering instruments duplicating those of the utility for check purposes and to give operators an indication of load conditions on the system. Instruments used by the utility for billing, demand and reactive power are duplicated by type and manufacturer. Wherever possible, the power company's instrument transformers are used.

Automated Plant Has One Operator (*Continued from page* 51)

will control hydrogen and oil temperatures. This turbine has steam-gland seals, and no changes will be made in the seals themselves. But changes will be made in the steam-line controls to take advantage of the latest refinements.

The computer will also control circulating water to the condenser, condenser hot-well level, the recirculating valve, air ejectors, and evaporators. Installation of these controls will require changes in established equipment, including those in the piping and valves.

The control room and the operator will be on the same floor, only a few feet from turbogenerators.

In the automation of Riverside two steps will be omitted because of their excessive cost with relation. Adjustment of turbine thrust will be handled manually. There will be only two positions of adjustment, one for starting and the other for running. The turbine will be placed on the rolling gear manually. An alarm will notify the operator when the unit has stopped and should be placed on the rolling gear.

Since Unit 1 is the older, considerable engineering will be required to make it conform to the characteristics of Unit 2. For example, the No. 1 turbine has water sealed glands. These will be changed to steam seals. Throttle and admission valves will have to be adapted for automatic control. Wide-range governor control and supervisory instruments identical to those of Unit 2 will be installed.

Gulf States has contracted with Allis-Chalmers and its affiliate, Consolidated Systems Corp, to supply and install the equipment for conversion of the plant to automatic operation.

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LINES UP!

an eighteen minute sound-color film produced by the Reliable Electric Company to demonstrate deadending and splicing by the newest mechanical methods with particular attention to live-line work.

Interesting scenes include field installation procedures; heavy short circuit tests, tensile and vibration tests and a few manufacturing details.

Your Reliable representative or distributor will be happy to arrange a showing on your premises at any time.

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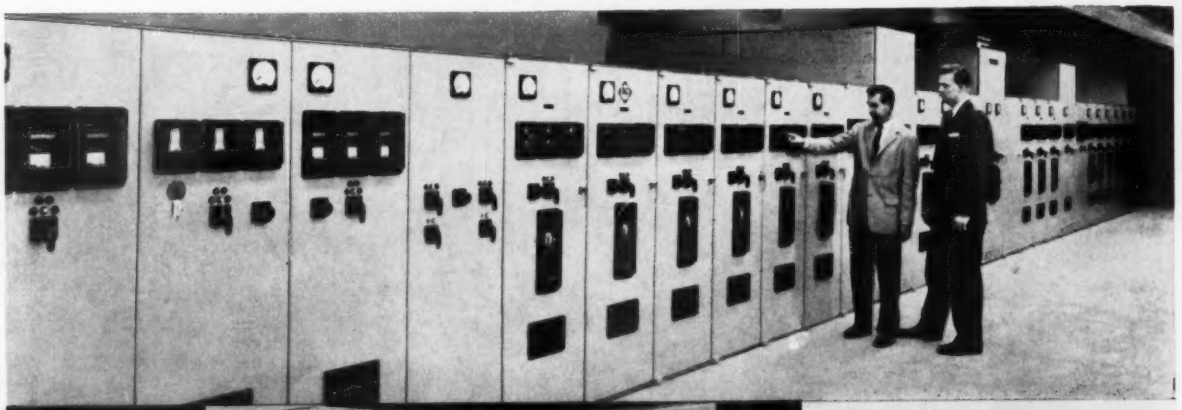
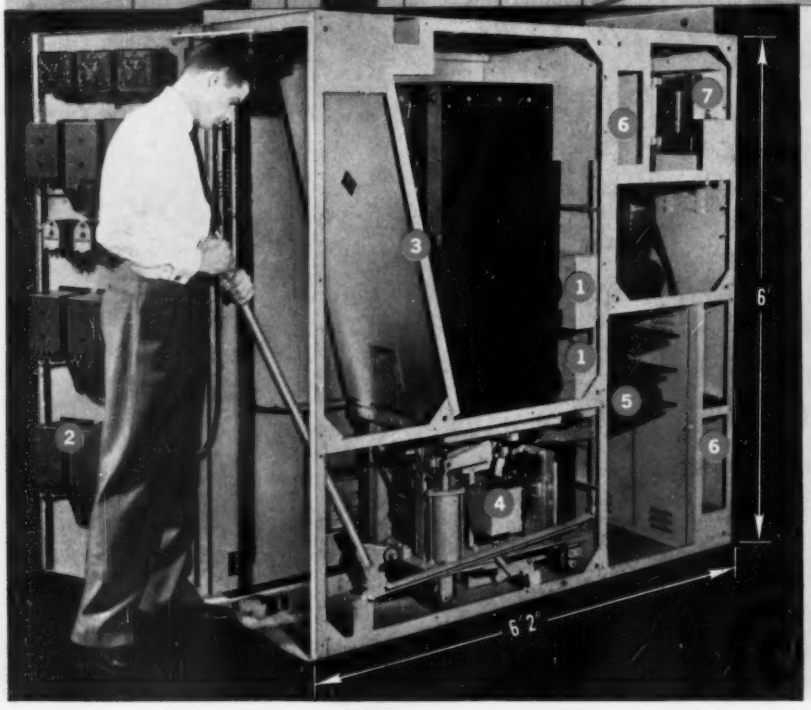
ALLIS-CHALMERS





▲ 4.16 kv metal-clad equipment serving a west coast city.

1. Separate compartments for current transformers.
2. Full panel metering and relaying.
3. Double-lock panel for operator safety.
4. Easy service accessibility without dismantling.
5. Glass polyester insulation throughout.
6. Separate up-feed and down-feed cable compartments.
7. Fully cast, trunnion-mounted potential transformers.

Lowest height, easiest access

the only switchgear with fully isolated current transformers

The front-accessible current transformers can be inspected, maintained or replaced without exposure to any high voltage compartment. A-C metal-clad units are just 72 inches high — means eye-level instrumentation . . . shoulder-height accessibility of component parts. And the entire panel can be used for meters and relays. Maximum compartmentation and dead-front construction offer greater safety. Buswork and components arranged for easy addition of future units.

You get rapid, one-stroke insertion of the circuit breaker. The breaker has glass polyester insulation for highest impulse strength . . . the only self-locking protective barrier . . . four-bar linkage is mechanically, electrically trip-free. Primary disconnect fingers eliminate use of garter springs, and are on the circuit breaker for easy inspection. Both stored energy and solenoid operators are available. *For more switchgear information contact your nearby* **Allis-Chalmers** *office.* A-1457